Anritsu

OPERATION MANUAL

MICROWAVE SYSTEM ANALYZER

ME453A/B/C
ME538A/B/C

REFERENCE
ONLY

ANRITSU ELECTRIC CO., LTD.

TOKYO, JAPAN

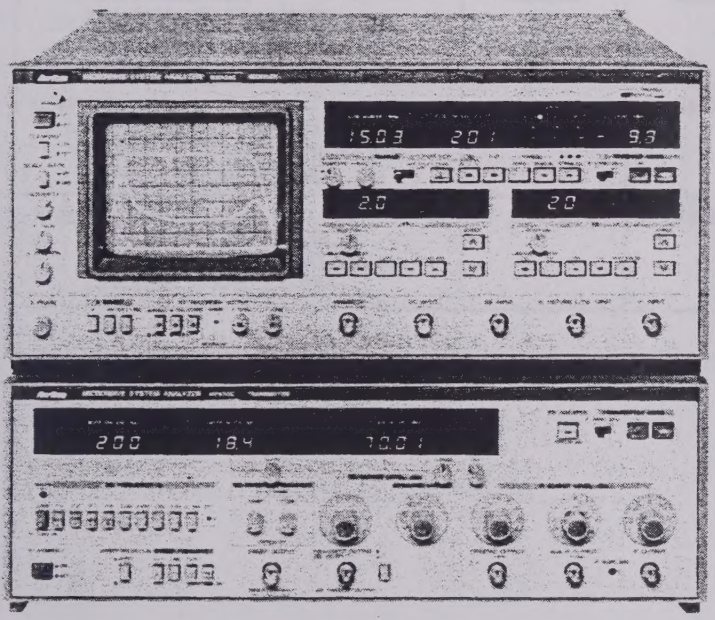
1983.05 x 110 NVI-5(Y)

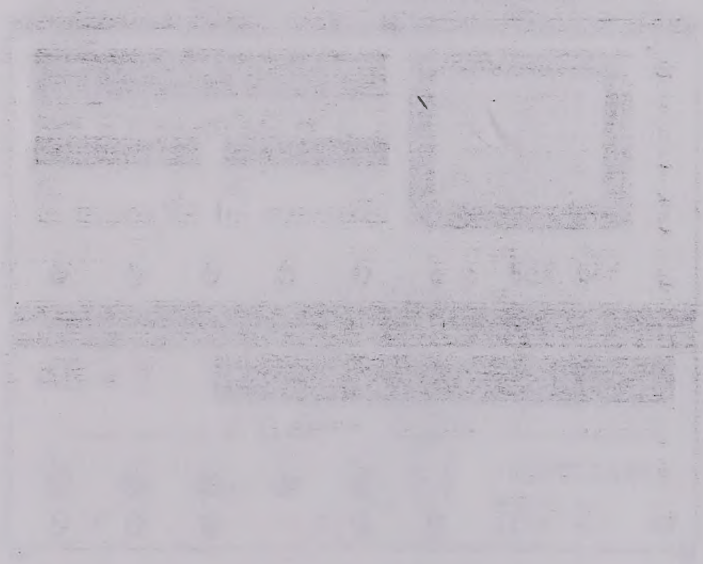
REFERENCE
ONLY

OPERATION MANUAL

MICROWAVE SYSTEM ANALYZER

ME453A/B/C
ME538A/B/C





THE SIX MODELS of THE MICROWAVE SYSTEM ANALYZER

IF / BB	70 MHz	70/140 MHz
200 kHz Series (A type) 66.667 kHz, 200 kHz, 400 kHz, 2 MHz, 3.58 MHz, 4.43 MHz, 5.6 MHz, 8.2 MHz, 12.39 MHz (ME538A)	ME453A	ME538A
277.778 kHz Series (B type) 92.593 kHz, 277.778 kHz, 555.556 KHz, 2.4 MHz, 3.58 MHz, 4.43 MHz, 5.6 MHz, 8.2 MHz, 12.39 MHz (ME538B)	ME453B	ME538B
250 kHz Series (C type) 83.333 kHz, 250 kHz, 500 kHz, 2.4 MHz, 3.58 MHz, 4.43 MHz, 5.6 MHz, 8.2 MHz, 12.39 MHz (ME538C)	ME453C	ME538C

1. General

APPLICATIONS AND ACCESSORIES 1

2. Operation panel explanation

TRANSMITTER 2

RECEIVER 3

3. MEASUREMENTS GUIDE 4

4. PRESETTING THE REAR PANEL 5

5. CONFIRMATION OF NORMAL CONDITIONS (BACK TO BACK CHECKS) 6

6. General measurements

IF TO IF (device, link and so forth) 7

BB TO IF (Modulator, link included modulator, and so forth) 8

IF TO BB (Demodulator, link included demodulator, and so forth) 9

BB TO BB (Link included modulator and demodulator, and so forth) 10

MODULATOR SENSITIVITY 11

FREQUENCY DEVIATION 12

DEMODULATOR SENSITIVITY 13

FREQUENCY ADJUSTMENT (Center Frequency of Modulator and IF signal) 14

IF RETURN LOSS 15

BB RETURN LOSS 16

BB TO BB AMPLITUDE RESPONSE (Swept method) 17

DC CHARACTERISTIC 18

AM-PM CONVERSION COEFFICIENT 19

For items other than the above, see 3, MEASUREMENTS GUIDE.

7. Special measurements

MEASUREMENT FOR COMMUNICATIONS SATELLITES 20

REMOTE MONITORING 21

8. Appendix

SPECIFICATIONS 22

CHART OF GROU-DELAY MEASURING ERROR DUE TO AM-PM CONVERSION 23

TABLE OF CONVERSION OF GROUP DELAY AND DIFFERENTIAL PHASE 24

APPLICATIONS

Application

The Microwave System Analyzer measures the characteristics of the IF and baseband of terrestrial radio relay links or satellite links.

The Microwave System Analyzer can be used to measure FDM-FM links and the new digital microwave communication links.

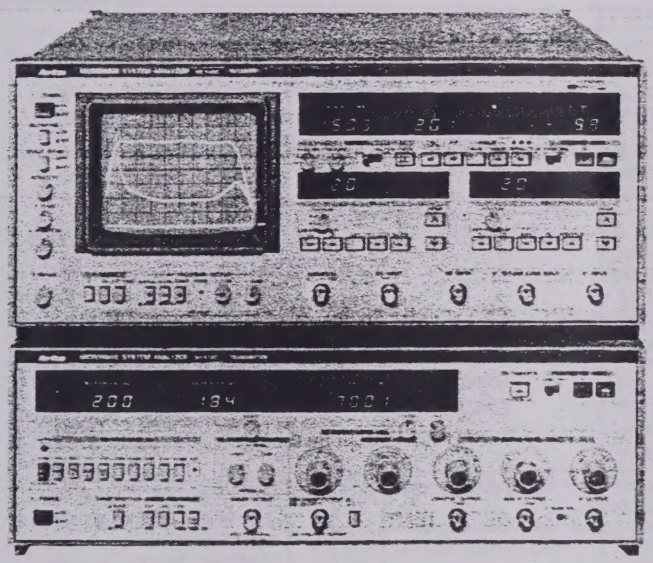
The Microwave System Analyzer is useful in link device adjustment, construction, maintenance, research and development applications.

Composition

The Microwave System Analyzer includes two panels as shown below and accessories.

Characteristics Measured

(1) Group delay characteristics
(2) Linearity of modulator and demodulator
(3) Differential phase characteristics
(4) Differential gain characteristics
(5) IF amplitude characteristics
(6) BB amplitude characteristics (option)
(7) IF return loss } Optional return loss
(8) BB return loss } bridges are necessary.
(9) Sensitivity of modulator and demodulator
(10) Frequency deviation
(11) AM to PM conversion coefficient
(12) DC characteristic
(13) Power, gain and loss



Receiver

Transmitter

Front view

ACCESSORIES

Furnished Accessories

This equipment is supplied with the following accessories.

Accessories	Q'ty	Remarks
Measuring cord	3	2 m
Power cord	2	
Fuse	2	
Operation manual	1	
Service manual	1	

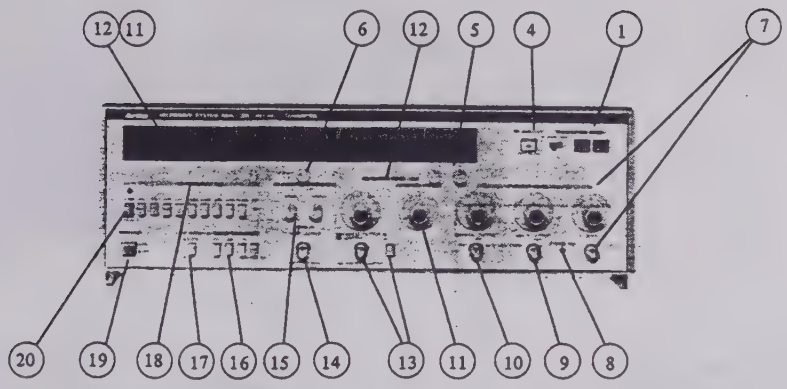
Options (ordered separately)

1. OPTION 01: BB Amplitude Measurement Facility
2. OPTION 02: X-Y Recorder Output Facility
3. OPTION 03: Sweep Frequency
   One frequency from 18 to 100 Hz.
4. OPTION 04: Receiver GP-IB

Optional Accessories (ordered separately)

1. IF Return Loss Bridge MR55A1
   Bridge balance: ≥54 dB (45 to 190 MHz)
2. BB Return Loss Bridge MR43A
   Bridge balance: ≥55 dB (100 kHz to 20 MHz)
3. Test Mobile
   MB24A: Fixed horizontal type
   MB23A: Tilt angle type
4. Carring Case
   Aluminium coated hard case with caster.

TRANSMITTER

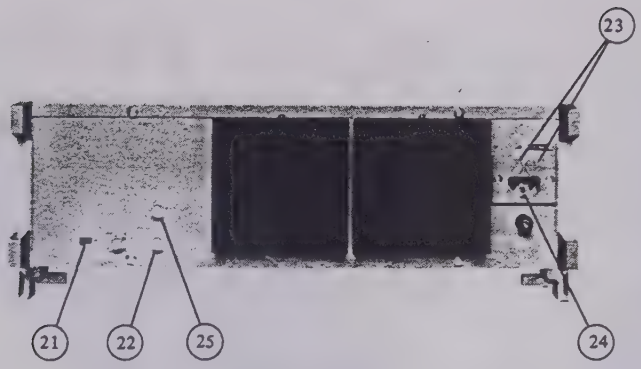


Front Panel

No.	Marking	Explanation
①	TRANSMITTER MODE	IF : Pushed when measuring IF to IF or IF to BB, for an IF device, demodulator, link, etc. BB : Pushed when measuring BB to IF and BB to BB, for a modulator, link, etc. IF BAND : 70 MHz/140 MHz band select switch.
④	BB SWEEPER	Pushed when measuring the amplitude characteristics of a BB device, link including modulator/demodulator, etc.
⑤	COARSE, FINE	Used to set the IF center frequency when the TRANSMITTER MODE key is in the IF position.
⑥	ADJUST	Set to SWEEP WIDTH ±MHz when the TRANSMITTER MODE key is in the IF position. Set to the BB + SWEEP OUTPUT terminal sweep output voltage (volts peak/75 Ω) when the TRANSMITTER MODE key is in the BB position.
⑦	IF OUTPUT LEVEL dBm, IF OUTPUT	The level set on the OUTPUT dial is output from this terminal.
⑧	IF SLOPE ADJ	Used when changing the slope of the IF OUTPUT amplitude characteristic.
⑨	AUX IF OUTPUT	Provides −10 dBm fixed output at the same frequency as the IF OUTPUT signal. Used for IF RETURN LOSS measurement.
⑩	CRYSTAL OUTPUT	70 MHz or 140 MHz crystal oscillator output.
⑪	DEVIATION kHz rms	Used to set the FM deviation when the TRANSMITTER MODE key is in the IF position. The deviation is displayed on the panel.

No.	Marking	Explanation
⑫	BB OUTPUT LEVEL dBm	Sets the BB OUTPUT level when the TRANSMITTER MODE key is in the BB position or the BB SWEEPER ④ switch is pushed.
⑬	BB + SWEEP OUTPUT/ BB OUTPUT	Selects composite signal of the BB signal and the sweep signal or the BB signal only.
⑭	SWEEP OUTPUT	A voltage equal to four times the value on the panel display set by ADJUST ⑥ is output for a 10 kΩ or more load when the TRANSMITTER MODE key is in the BB ② position.
⑮	BB SWEEPER FREQUENCY	The START knob is used to set the lower limit of the frequency sweep range and the STOP knob is used to set the upper limit.
⑯	SWEEP FREQUENCY	Switch for setting the sweep frequency.
⑰	SWEEP REDUCTION	When this switch is ON, the carrier sweep width is reduced automatically by the modulation frequency so that SWEEP WIDTH = carrier sweep width + modulation frequency. Where modulation frequency > 1 MHz.
⑱	BB FREQUENCY	Modulation frequency select switch.
⑲	POWER	Power switch.
⑳	AM-PM	Used when measuring the AM to PM conversion factor. When this switch is pushed, AM is applied to the IF output signal and a modulation frequency from 200 to 278 kHz is selected. However, the deviation must be set to 200 kHz rms when making this measurement.

TRANSMITTER

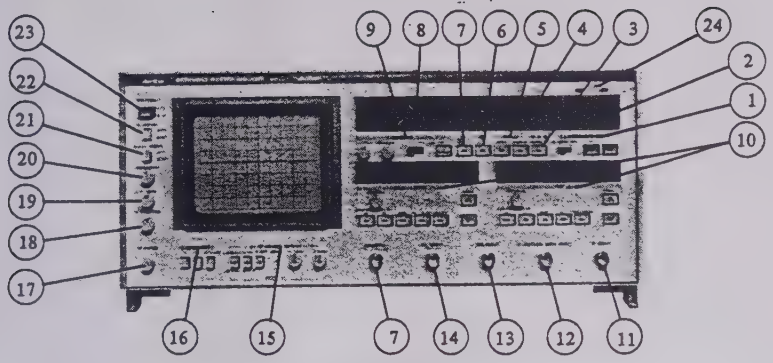


Rear Panel

No.	Marking	Explanation
(21)	BB FREQ SELECT:	When this switch is set to INT, the transmitter is operated by the internal BB OSC selected with BB FREQUENCY (18). When this switch is set to EXT, the transmitter can be operated by an external oscillator. In the remote monitoring arrangement, connect the BB OUT on the rear panel of the receiver to EXT on the rear panel of the transmitter.

No.	Marking	Explanation
(22)	EXT SWEEP FREQUENCY	When this is connected to an external oscillator and the EXT of switch (16) is pushed, the transmitter is operated by the external oscillator.
(23)	FUSE	Fuse holder.
(24)	AC**V	ac inlet.
(25)	SWEEP OUTPUT	Output terminal for sweep signal (Output level is approx. 1 Vp-p)

Note: [*] indicates that the option is not equipped.



Front Panel

FRONT PANEL

No.	Marking	Explanation
(1)	RECEIVER MODE	IF : Pushed when measuring IF to IF or BB to IF, for an IF device, modulator, link, etc. BB : Pushed when measuring BB to BB or IF to BB, for a demodulator, link, etc. IF BAND : IF band select switch.
(2)	IF LEVEL dBm	Displays the −20 to +10 dBm IF input level. Flashes in case of overrange and underrange.
(3)	NORMLZR (Normalizer)	Used for noise rejection and subtraction. When this key is pushed, the measured image on the CRT changes according to the function as follows: AVG (STO) (Average and stored): (i) Approximately 2 sec after the LED lights, averaging of CRT image begins and noise is rejected. (ii) Approximately 2 sec after the LED lights, the stored memory is held. If the NORMLZR key is pushed again within 2 sec, the stored memory is held and it is possible to shift to the next function. Y-STO (Y input signal minus stored signal): For example, accurate measurement with the inherent slope removed can be performed by storing the measurement system inherent slope with the AVG (STO) function and taking measurements with the Y-STO function. AVG-STO (Average Y input signal minus stored signal): This is used when the Y input signal is noisy. It has the same functions as Y-STO, except for improved measured image noise.

No.	Marking	Explanation
(4)	BB FREQUENCY Hz	The received modulation frequency is indicated automatically by an LED. When the delay DP phase lock loop is not operating normally, the LED flashes.
(5)	RANGE	AUTO : The CRT sensitivity is adjusted automatically according to the measured waveform. Initial setup is this state. MANUAL : The CRT sensitivity is changed with the Y1 and Y2 RANGE keys.
(6)	P-P (peak to peak)	Displays the deviation (slope) of the measured image on the CRT - that is, it directly displays the peak-to-peak value.
(7)	CAL	DEVIATION : The CAL key is pushed to calibrate the deviation display after the SPECTRUM key is pushed and zero carrier on the CRT is confirmed. After calibration, set the CAL key to OFF.

Type	Modulation frequency	Deviation
A	200 kHz	340 kHz rms
B	277.778 kHz	472 kHz rms
C	250 kHz	425 kHz rms

RET LOSS : When the RET LOSS key is pressed, a bridge is connected to the MISMATCH 20 dB terminal. Then the CAL key is pressed and 20 dB appears on the Y1 LED and a return loss measurement system is calibrated.

LOCAL — When this instrument is controlled through GPIB (option), this key switches REMOTE control to LOCAL control.
See GPIB operation manual.

No.	Marking	Explanation
(8)	BB LEVEL dBm DEVIATION kHz rms	The FM deviation is displayed when the RECEIVING MODE (1) is in the IF position and the BB input level is displayed when the RECEIVING MODE (1) is in the BB position.

No	Marking	Explanation
⑨	MARKER	POSITION : Moves the marker reference line up and down. FREQUENCY : Sliding side marker frequency controller. SLIDE MARKER ± MHz: Sliding side marker frequency. (Switch) : SLIDE - Slide marker OFF - Marker off 2 MHz COMB + SLIDE — A marker combining the 2 MHz interval comb marker and slide marker is output. CHECK (Polarity check) : When this key is pushed, a half of the marker train at high frequency is extinguished. In the opposite case, change the CRT X-phase by using X PHASE ⑰.
⑩	Y1, Y2	

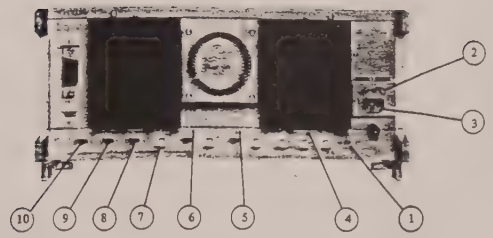
Key	Item	Units RANGE	Units P-P
LINEARITY DG.	Linearity Differential Gain	% /DIV	% P-P
DELAY	Group Delay (modulation frequency < 1 MHz)	ns /DIV	ns P-P
DP	Differential phase (modulation frequency > 1 MHz)	DEG /DIV	DEG P-P
AMPL	Amplitude Response	dB /DIV	dB P-P
RET LOSS	Return Loss	dB /DIV 1dB/DIV	–
AM-PM	AM to PM Conversion coefficient	°/dB /DIV	°/dB P-P
DC	DC input level	mV /DIV	–
SPECTRUM	Frequency spectrum	–	–

POSITION : Moves the Y1 and Y2 images up and down.

RANGE: Operates when RANGE ⑤ is in MANUAL mode.

⑪	IF INPUT	Input terminal for IF signal measurement.
⑫	RETURN LOSS INPUT	Used in IF band return loss measurement. Receives a small amount of power from the IF return loss bridge.
⑬	BB INPUT	Input terminal for BB signal measurement.
⑭	DC INPUT	Input terminal for DC voltage measurement.

No.	Marking	Explanation
⑮	X-Y RECORDER OUTPUT	A hard copy of the measured image on the CRT can be made by connecting the rear panel X, Y OUTPUT terminals ④ to an X-Y recorder. 40 SEC, 20 SEC : Pen speed select switch. CAL : A spot appears at the right top and left bottom corners of the CRT scale and a signal corresponding to these spots is simultaneously output from the X, Y output terminals. This output is used to calibrate X-Y recorder sensitivity and position. MEAS : Set this switch to MEAS when the calibration of X-Y recorder is completed. START, WRITE : Pushed to start a hard copy. During the operation of hard copy, WRITE LED lights up. X GAIN, Y GAIN : Used to set the sensitivity of X-Y recorder.
⑯	X SELECT	CRT horizontal axis selector switch. IF : The X-axis is produced by reproducing the X-axis component from the swept IF signal from the IF INPUT terminal. BB : The X-axis is produced by detecting the X-axis component from the BB input signal. At this time, the BB input signal must contain a horizontal signal. EXT/LINE : Used to select an external signal or ac line signal. The desired signal is selected with the rear panel EXT/LINE selector.
⑰	X PHASE	Horizontal phase adjuster.
⑱	X POSITION	Horizontal position adjuster.
⑲	X GAIN	Horizontal signal gain adjuster.
⑳	INTENSITY	CRT intensity adjuster.
㉑	SCALE INTEN	Used when photographing the CRT image. Varies the CRT brightness.
㉒	BLANKING	Switch for blanking the fly-back line of the horizontal-axis sweep of the CRT.
㉓	POWER	Power switch.
㉔	CONTROL REMOTE LOCAL	This indicates control status REMOTE or LOCAL. LOCAL is lit usually. See GPIB operation manual.



Rear Panel

No.	Marking	Explanation
①	TRACE ROTATION	Adjusts the horizontal axis tilt.
②	FUSE	Fuse holder.
③	AC **V	ac inlet
④	X-Y RECORDER OUTPUT	Used to output the measured image on the CRT to an X-Y recorder. The switches ⑮ on the front panel control this output.
⑤	MARKER SELECT	INT : Normally set in this state. EXT : Used when detecting the marker with an external detector.
⑥	EXT/LINE SELECT	Effective when front panel X SELECT ⑯ is set to EXT/LINE. EXT : Used when an external oscillator is used. LINE : Used when the horizontal signal is synchronized with the ac line signal.
⑦	BB OUTPUT	BB output terminal for remote monitoring. Connects to BB FREQ SELECT-EXT on the rear panel of the transmitter.
⑧	THRESHOLD EXTENSION	Filter switch to protect the discriminator when the IF signal contains mush noise. ON : Narrow bandpass filter is inserted in front of the discriminator. Therefore, the modulation frequency must be less than 556 kHz.

No.	Marking	Explanation
⑨	CRT TRACE	CHOP (chopping) : The Y1 and Y2 marker multitrace display is chopped at high speed. Used in normal measurement. ALT (Alternate) : Switches the Y1 and Y2 and marker at each X-axis sweep. When measuring an especially sharp characteristic, a clear measured image is obtained, but if the sweep frequency is low, the image flickers.
⑩	PLL CUT FREQ (Phase locked loop cut frequency)	HIGH : Set when the sweep frequency is 20 Hz or higher. The group delay detection response is fast. LOW : Set when the sweep frequency is under 20 Hz. The group delay detection response is slow, but the correct measured value is obtained.

Note: * indicates that the option is not equipped.

MEASUREMENT GUIDE

R SUPPLY

er to be supplied to the Microwave System Analyzer be as follows:

er voltage: AC 100 V to 130 V, 200 V to 260 V.
The power voltage is set by the manufacturer to the value specified by the Customer.

er capacity: Approx. 220 VA

er frequency

rance: 48 Hz to 66 Hz

ore turning on the power, make sure that the power supply a is within ±10% of the rated voltage value which is shown rear panel.

few minutes after power is turned on, measurement can

und the measuring equipment and the units to be measured. rise, voltage may be generated between their frames.

E (Transmitter and receiver mode)

r example, when measuring a demodulator (IF to BB), push RANSMITTER MODE IF and RECEIVER MODE BB es. The parameters needed for measurement will be displayed panel.

NSMITTER MODE

: DEVIATION kHz rms, SWEEP WIDTH ±MHz, IF CENTER FREQ MHz, (IF OUTPUT LEVEL dBm)

: BB OUTPUT dBm, SWEEP OUTPUT Vp/75Ω

CEIVER MODE

ommon : SLIDE MARKER ±MHz, IF LEVEL dBm

: DEVIATION kHz rms

: BB LEVEL dBm

(Calibration)

See item (7) of the operation panel explanation of front panel on page 3.

DEVIATION: This key operates when the SPECTRUM Y2-SPECTRUM key has been pushed, the modulation frequency conforms to the table below and the CRT carrier zero (2.405 radian) was performed correctly (within approx. 30%).

Type	Modulation frequency	Calibration factor
A	66.667 kHz	113 kHz rms
	200 kHz	340 kHz rms
B	92.593 kHz	157 kHz rms
	277.778 kHz	472 kHz rms
C	83.333 kHz	142 kHz rms
	250 kHz	425 kHz rms

LOSS : Effective only for the RETURN LOSS function. The internal calibration factor is 20 dB, but can be changed with Y1 RANGE keys.

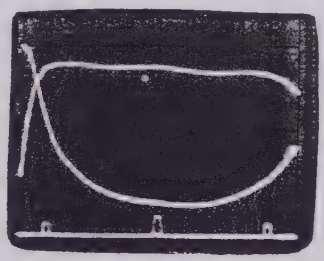
trace : If this key is pushed when the linearity, DG, delay, DP, or BB ampl function is being performed, the internal calibrator causes two lines to appear on the CRT.

tween of : Linearity/DG-10%, Delay-10ns, DP-1°, BB
it trace Ampl – 1 dB.

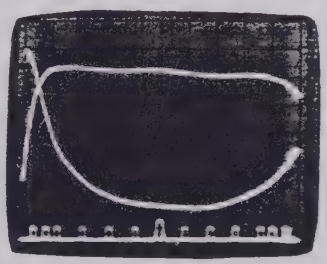
te : Before taking measurements, press the CAL key again (the LED turns off).

MARKER

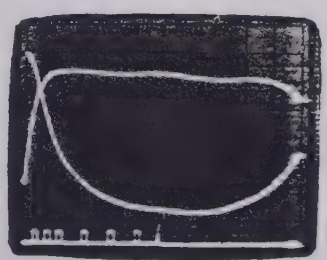
SLIDE : A side marker that slides as shown below is displayed on the CRT. The marker frequency is displayed on the panel.



2 MHz COMB + SLIDE : The 2 MHz interval comb markers and the sliding side marker are displayed simultaneously on the CRT shown below.

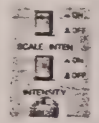


CHECK : Used to confirm that the right side of the X-axis (frequency) is high frequency.

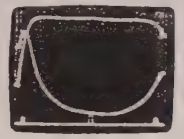


SCALE INTEN (Scale intensity)

When photographing the CRT screen, the scale can be made to appear clearly as shown below by setting the SCALE INTEN switch to ON (pushed).



SCALE INTEN-OFF

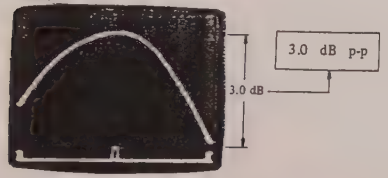


SCALE INTEN-ON

P-P (peak to peak)

The size of the measured image is displayed directly.

example



SWEEP REDUCTION

See item (17) of the operation panel explanation on page [2].

When the modulation frequency (BB FREQUENCY) is above 1 MHz, the carrier sweep width is reduced by this frequency. (However, the amplitude of the SWEEP + BB OUTPUT and SWEEP OUT sweep signal is not reduced.) Care must be taken since the transmitter sweep width display and sweep width by receiver marker are different by the value of the modulation frequency. (The marker indicates only the carrier sweep component.)

X PHASE and X SELECT

See item (16) of the operation panel explanation on page [3]. When BB and EXT/LINE are selected, a variable phase width of 360° or more is obtained. However, when IF is selected, the horizontal phases are almost matched and the X PHASE variable width is small.

SWEEP OUTPUT

See item (14) of the operation panel explanation on page [2].

When the load is 10 kΩ or greater, the voltage output to the load is four times the value indicated on the panel.

For example, when

SWEEP OUTPUT Vp/75Ω 3.00	p-p: 6 V

the output voltage becomes

12 V peak to load:	p-p: 24 V

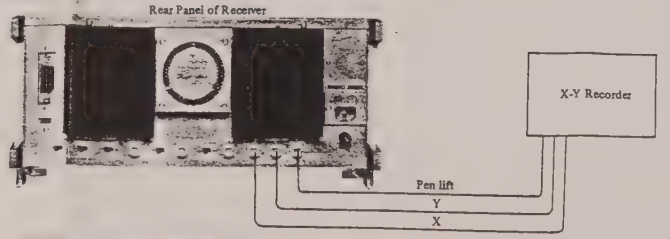
FM DEVIATION

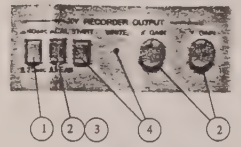
Transmitter accuracy: within ±10%
Receiver accuracy: within ±10%

(High accuracy measurement by the Receiver is possible by performing the CALIBLATION described on page [12] and [22].)

X-Y RECORDER OUTPUT

Connection



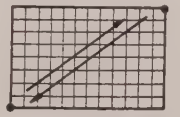


Set the controls as follows.

(1) 40 sec, 20 sec : Pen speed selector. Set to required speed.

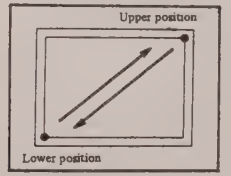
(2) CAL, MEAS : CAL. Adjust the upper pen position by turning the X, Y GAIN knobs.

CRT scale



The spot moves at 3 seconds interval.

X-Y Recorder



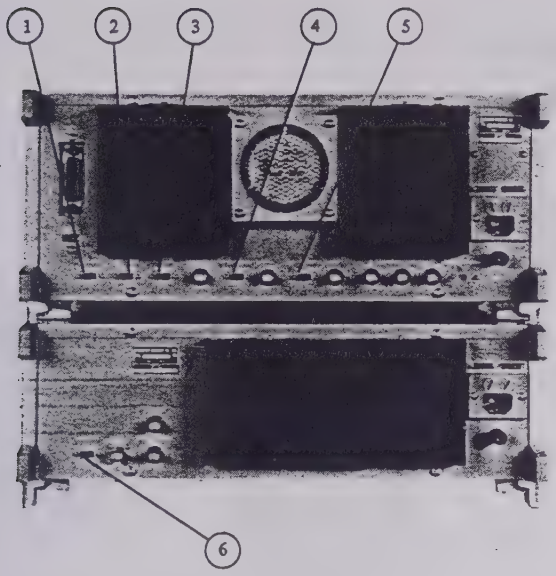
The pen moves from the lower to the upper position at 3 second intervals.

– X-Y Recorder settings –
Lower position:
X – 0 V (ground)
Y – 0 V (ground)
Upper position:
X – +4 V
Y – +4 V
Pen control:
Up—open
Down—ground

(3) CAL, MEAS : MEAS

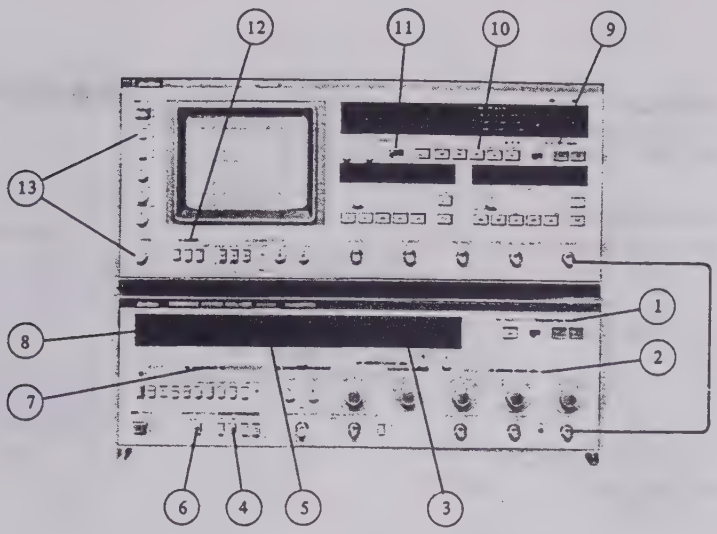
(4) START : Push. X-Y Recorder starts to copy the characteristic.

PRESETTING THE REAR PANEL



(1)	PLL CUT FREQ	HIGH	Set to LOW when sweep frequency is less than 20 Hz.
(2)	CRT TRACE	ALT	Set to CHOP when sweep frequency is low (≤approx. 20 Hz) to obtain a clear trace line.
(3)	THRESHOLD EXTENSION	OFF	Set to ON when there is much noise in the IF input signal. However, the modulation frequency must be less than 556 kHz.
(4)	EXT/LINE SELECT	LINE	Set to EXT when using an external sweep signal.
(5)	MARKER SELECT	INT	Set to EXT when using an external frequency marker detector.
(6)	BB FREQ SELECT	INT	Set to EXT when using an external oscillator.

6 CONFIRMATION OF NORMAL CONDITIONS (BACK TO



5 Presetting the REAR PANEL

IF to IF (Connect the IF OUTPUT to the IF INPUT directly)
Set the controls as follows:

	TRANSMITTER:	
(1)	TRANSMITTER MODE	
	IF BAND	Required band (for ME538A/B/C).
	BB, IF	IF.
(2)	IF OUTPUT LEVEL dBm	0 dBm.
(3)	IF CENTER FREQ MHz	70 MHz or 140 MHz.
(4)	SWEEP FREQUENCY	LINE.
(5)	SWEEP WIDTH ±MHz	25 MHz/70 MHz BAND or 50 MHz/140 MHz BAND
(6)	SWEEP REDUCTION	ON
(7)	BB FREQUENCY Hz	200 kHz, 278 kHz or 250 kHz for Delay, Linearity Measurement. 5.6 MHz for DG, DP Measurement.
(8)	DEVIATION kHz rms	200 kHz rms for Delay Linearity Measurement. 500 kHz rms for DG, DP Measurement.
	RECEIVER:	
(9)	RECEIVER MODE	
	IF BAND	70 or 140 MHz.
	BB, IF	IF.
(10)	RANGE	AUTO.
(11)	MARKER	SLIDE, FREQUENCY – Set to ±25 MHz/70 MHz BAND or ±50 MHz/140 MHz BAND
(12)	X SELECT	IF.
(13)	X PHASE	Adjust the knob to coincide the tracing marker pulses with the retracing marker pulse while the BLANKING is OFF. After adjusting, set the BLANKING switch to ON.

IF LEVEL

If the difference between the IF OUTPUT LEVEL and IF INPUT LEVEL is less than 0.6 dB, IF LEVEL is normal.

IF AMPLITUDE

(a) Y1 selectors AMPL
Y2 selectors OFF
If the item key- LEDs light, push these keys again. The LEDs turn off and these function enters the OFF state.

(b) Confirmation: The slope should be less than ±0.05 dB/ 70 ±25 MHz, ±0.2 dB/140 ±50 MHz.

Note: SLOPE ADJ is used for compensation of the cable characteristics.

GROUP DELAY & LINEARITY

(a) (Transmitter) BB FREQ: Set as follows.
Type A 200 kHz.
Type B 278 kHz.
Type C 250 kHz.

(b) (Transmitter) DEVIATION: 200 kHz rms.

(c) Y1 selectors: DELAY/DP.

(d) Confirmation: The slope of the trace should be less than 0.5 ns/70 ±25 MHz, 1 ns/140 ±50 MHz.

(e) Y2 selectors: LINEARITY/DG.

(f) Confirmation: The slope should be less than 0.2%/ 70 ±25 MHz, 0.2 %/140 ±50 MHz.

Differential Phase & Differential Gain

(a) (Transmitter) BB FREQ: Set to 5.6 MHz

(b) (Transmitter) DEVIATION: 500 kHz rms.

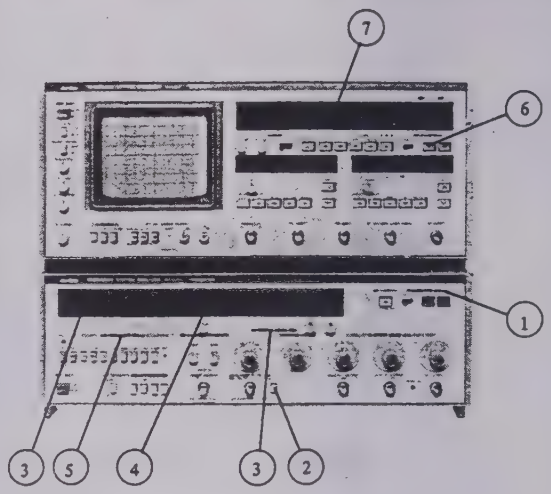
(c) Y1 selectors: DELAY/DP.

(d) Confirmation: The slope should be less than 0.5°/70 ±(25−BB FREQ) MHz, 0.8°/140 ±(50−BB FREQ) MHz.

(e) Y2 selectors: LINEARITY/DG.

(f) Confirmation: The slope should be less than 0.4%/ 70 ±(25−BB FREQ) MHz, 0.6 %/140 ±(50−BB FREQ) MHz.

BB to BB (connect the BB OUTPUT to the BB INPUT directly)



Set the controls as follows:

TRANSMITTER:		
(1)	TRANSMITTER MODE	BB.
(2)	(OUTPUT SELECT)	BB OUT
(3)	BB OUTPUT LEVEL dBm	0 dBm.
(4)	SWEEP OUTPUT	zero.
(5)	BB FREQUENCY	Push the keys in sequence, after RECEIVER settings.
RECEIVER:		
(6)	RECEIVER MODE	BB.
(7)	BB LEVEL dBm	Read the level.

BB LEVEL

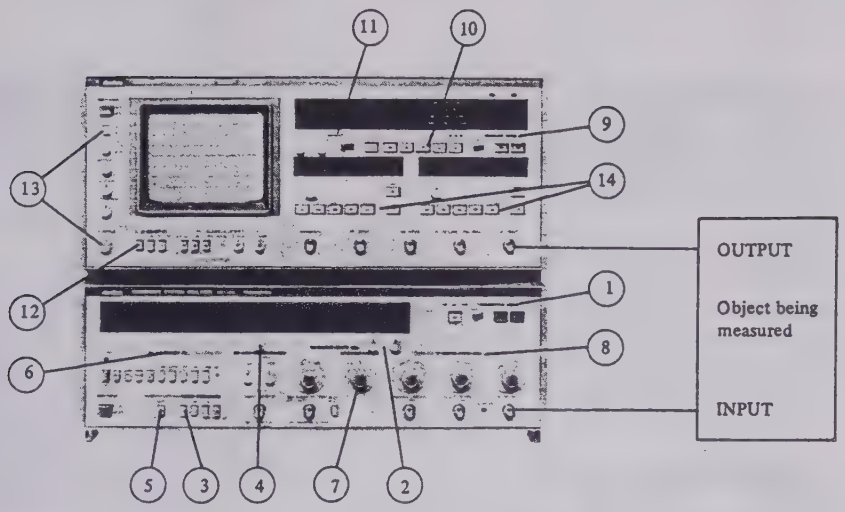
If the difference between BB OUTPUT level and BB LEVEL is less than 0.6 dB, BB level is normal.

Other BB to BB characteristics

If the IF to IF characteristics are normal, BB to BB measurement facilities are normal.

7

IF TO IF (IF device, link and so forth)



5

Presetting the REAR PANEL

Set the controls as follows:

TRANSMITTER:		
(1)	TRANSMITTER MODE	
	IF BAND	Required IF band.
	BB, IF	IF.
(2)	IF CENTER FREQ	Required center frequency.
(3)	SWEEP FREQUENCY	LINE.
(4)	SWEEP WIDTH ±MHz	Required sweep width.
(5)	SWEEP REDUCTION	Push ON if the automatic sweep reduction function is required.
(6)	BB FREQUENCY Hz	Required modulation frequency. For Delay measurement, set the BB frequency to less than 1 MHz, for DG and DP measurements, set the BB frequency more than 1 MHz ($\leqq$8.2 MHz).
(7)	DEVIATION kHz rms	200 kHz rms for Delay measurement. 500 kHz rms for DG and DP measurements.
(8)	IF OUTPUT LEVEL dBm	Level specified by application.
RECEIVER		
(9)	RECEIVER MODE	
	IF BAND	Required band.
	BB, IF	IF.
(10)	RANGE	AUTO.
(11)	MARKER	SLIDE. Set the frequency to observing band width.
(12)	X SELECT	IF.
(13)	X PHASE, BLANKING	Adjust the knob to coincide the tracing marker pulse with the retracing marker pulse while the BLANKING switch is OFF. After adjusting, set the BLANKING switch to ON.
(14)	Measurements	Push the Y1, Y2 measuring item keys.

IF TO IF

(1) Group Delay Measurement
(a) Y1 keys DELAY/DP.
(b) Confirm that modulation frequency is less than 1 MHz and deviation is about 200 kHz rms.
(c) Scale sensitivity is displayed in ns/DIV.

(2) IF Amplitude Measurement
(a) Y1 keys AMPL.
(b) Caution: To measure characteristics with steep slope, lower FM deviation or set it to zero.
(c) Scale sensitivity is displayed in dB/DIV.
Note: Detected amplitude signal is dc-coupled to CRT in the 1 dB/DIV and 2 dB/DIV scale sensitivities.

(3) Differential Phase Measurement
(a) Y1 keys DELAY/DP.
(b) Confirm that modulation frequency is more than 1 MHz ($\leqq$8.2 MHz), and FM deviation is about 500 kHz rms.
Note: To convert to delay time, use the equation below:

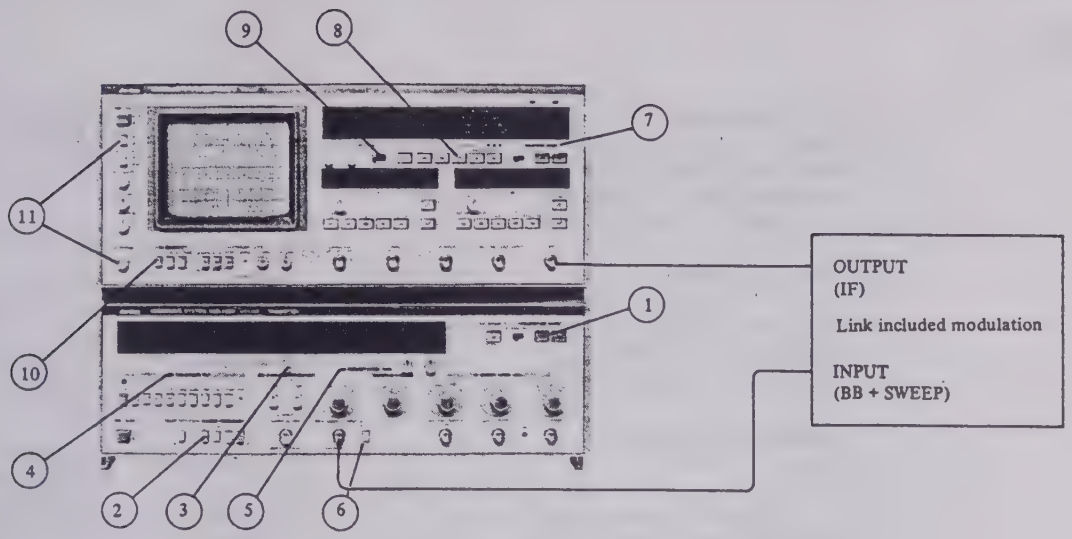
$$\tau\,(\text{ns}) = \frac{\text{DP (degree)}}{0.36 \times \text{fm (MHz)}}$$

Table of conversion of group delay and the differential phase calculated through the equation above is shown in Appendix 24.
(c) Scale sensitivity is displayed in DEG/DIV.

(4) Differential Gain Measurement
(a) Y1 keys LINEARITY/DG.
(b) Confirm that modulation frequency is more than 1 MHz ($\leqq$8.2 MHz), and FM deviation is about 500 kHz rms.
(c) Scale sensitivity is displayed in %/DIV.

(5) Dual Trace Display
(a) Key in the two measurement items to be simultaneously measured at Y1 and Y2.
(b) Dual trace display of measurement items having respective different modulation frequencies, such as delay and DP measurement items for example, is impossible.
Note: For dual trace display including measurement of return loss, see paragraph 15.

BB TO IF (Modulator, link included



5 ⇦ **Presetting the REAR PANEL**

Set the control as follows:

TRANSMITTER:		
(1)	TRANSMITTER MODE	BB.
(2)	SWEEP FREQUENCY	LINE.
(3)	SWEEP OUTPUT Vp/75Ω	Set the voltage using the following equation. $\text{Volts peak} = \frac{\text{Sweep width (HzP-P)}}{2} \times \frac{\text{test tone level of test point (Vrms/75}\Omega\text{)}}{\text{test tone deviation of test point (Hz rms)}}$ It is convenient to set the voltage by IF sweep width.
(4)	BB FREQUENCY	Required modulation frequency. For Linearity and Delay measurement, set the BB frequency to less than 1 MHz, for DG and DP measurement, set the BB frequency to more than 1 MHz ($\leq$8.2 MHz).
(5)	BB OUTPUT LEVEL dBm	Set level corresponds to FM deviation 200 kHz rms for Linearity and Delay measurement, or FM deviation 500 kHz rms for DG and DP measurement.
(6)	(OUTPUT SELECT)	BB + SWEEP OUTPUT ⊥
RECEIVER		
(7)	RECEIVER MODE	
	IF BAND	Required band.
	BB, IF	IF
(8)	RANGE	AUTO.
(9)	MARKER	SLIDE. Set the frequency to the observing bandwidth.
(10)	X SELECT	IF.
(11)	X PHASE, BLANKING	Adjust the knob to coincide the tracing marker pulse with the retracing marker pulse while the BLANKING switch is OFF. After adjusting, set the BLANKING switch to ON.
(12)	Measurements	Push the Y1, Y2 measuring item keys.

modulator, and so forth) BB TO IF

(1) **Group Delay Measurement**
(a) Y1 keys DELAY/DP.
(b) Confirm that modulation frequency is less than 1 MHz and deviation is about 200 kHz rms.
(c) Scale sensitivity is displayed in ns/DIV.

(2) **Linearity Measurement**
(a) Y1 keys LINEARITY/DG.
(b) Confirm that modulation frequency is less than 1 MHz and deviation is about 200 kHz rms.
(c) Scale sensitivity is displayed in %/DIV.

(3) **IF Amplitude Measurement**
(a) Y1 keys AMPL.
(b) Caution: To measure characteristics with steep slope, lower FM deviation or set it to zero.
(c) Scale sensitivity is displayed in dB/DIV.
Note: Detected amplitude signal is dc-coupled to the CRT in the 1 dB/DIV and 2 dB/DIV scale sensitivities.

(4) **Differential Phase Measurement**
(a) Y1 keys DELAY/DP.
(b) Confirm that modulation frequency is more than 1 MHz ($\leq$8.2 MHz), and FM deviation is about 500 kHz rms.
Note: To convert to delay time, use the equation below:

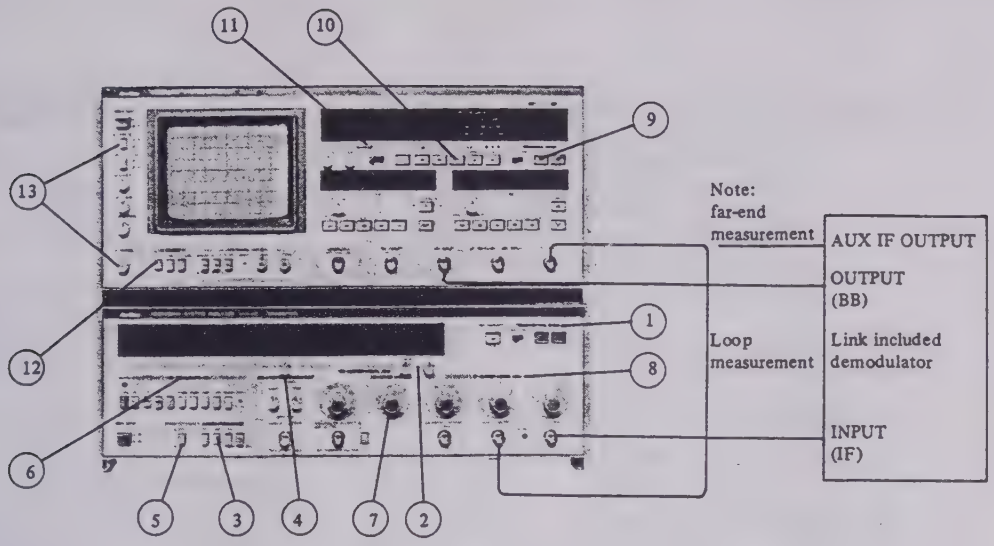
$$\tau\,(\text{ns}) = \frac{\text{DP (degree)}}{0.36 \times \text{fm (MHz)}}$$

A conversion table for group delay and the differential phase calculated using the above equation is given in Appendix [24].

(5) **Differential Gain Measurement**
(a) Y1 keys LINEARITY/DG.
(b) Confirm that modulation frequency is more than 1 MHz ($\leq$8.2 MHz), and FM deviation is about 500 kHz rms.
(c) Scale, sensitivity is displayed in %/DIV.

(6) **Dual Trace Display**
(a) Key in the two measurement items to be simultaneously measured at Y1 and Y2.
(b) Dual trace display of measurement items having respective different modulation frequencies, such as delay and DP measurement items for example, is impossible.
Note: For dual trace display including measurement of return loss, see paragraph [15].

IF TO BB (Demodulator, link included



5 **Presetting the REAR PANEL**
set the controls as follows:

TRANSMITTER:		
(1)	TRANSMITTER MODE	
	IF BAND	Required IF band.
	BB, IF	IF.
(2)	IF CENTER FREQ	Required center frequency.
(3)	SWEEP FREQUENCY	LINE.
(4)	SWEEP WIDTH ±MHz	Required sweep width.
(5)	SWEEP REDUCTION	Push ON if the automatic sweep reduction function is required.
(6)	BB FREQUENCY Hz	Required modulation frequency. For Delay measurement, set the BB frequency to less than 1 MHz, for DG and DP measurements, set the BB frequency more than 1 MHz ($\leqq$8.2 MHz).
(7)	DEVIATION kHz rms	200 kHz rms for Delay and Linearity measurements, 500 kHz rms for DG and DP measurements.
(8)	IF OUTPUT LEVEL dBm	Level specified by application.
RECEIVER:		
(9)	RECEIVER MODE	BB.
(10)	RANGE	AUTO.
(11)	MARKER	SLIDE. Set the frequency to observing bandwidth.
(12)	X SELECT	IF. (Refer to note 1)
(13)	X PHASE, BLANKING	Adjust the knob to coincide the tracing marker pulse with the retracing marker pulse while the BLANKING switch is OFF. After adjusting, set the BLANKING switch to ON.
(14)	Measurements	Push Y1, Y2 measuring keys. Do not select the AMPL and RET. LOSS keys. (If BB SWEEPER option 01 is installed, oscillation of the X axis on the CRT will stop.)

demodulator, and so forth) IF TO BB

Note 1: For end to end measurement, horizontal-axis signal and frequency marker can be obtained by supplying the signal branched from the IF section of the object being measured to the IF INPUT connector. If this branching is difficult, set the X SELECT to BB, and set MARKER to OFF. However, in this case, the BB INPUT input signal must include the sweep frequency component.

(1) **Group Delay Measurement**
(a) Y1 keys DELAY/DP.
(b) Confirm that modulation frequency is less than 1 MHz and deviation is about 200 kHz rms.
(c) Scale sensitivity is displayed in ns/DIV.

(2) **Linearity Measurement**
(a) Y1 keys LINEARITY/DG.
(b) Confirm that modulation frequency is less than 1 MHz and deviation is about 200 kHz rms.
(c) Scale sensitivity is displayed in %/DIV.

(3) **Differential Phase Measurement**
(a) Y1 keys DELAY/DP.
(b) Confirm that modulation frequency is more than 1 MHz ($\leq$8.2 MHz), and FM deviation is about 500 kHz rms.

Note: To convert to delay time, use the equation below:

$$\tau\,(\text{ns}) = \frac{\text{DP (degree)}}{0.36 \times \text{fm (MHz)}}$$

A conversion table for group delay and the differential phase calculated with the above equation is given in Appendix [24].

(c) Scale sensitivity is displayed in DEG/DIV.

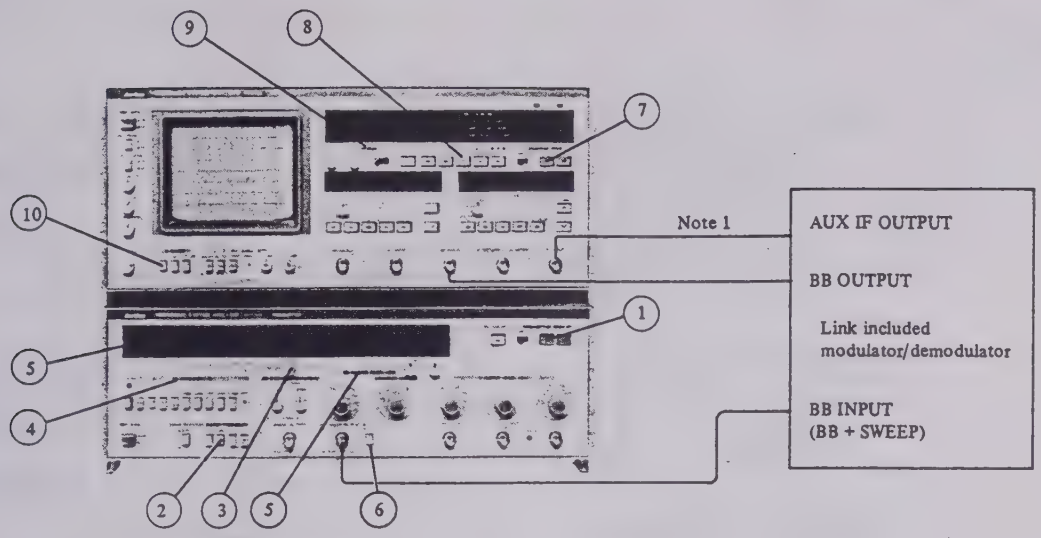
(4) **Differential Gain Measurement**
(a) Y1 keys LINEARITY/DG.
(b) Confirm that modulation frequency is more than 1 MHz ($\leq$8.2 MHz), and FM deviation is about 500 kHz rms.
(c) Scale sensitivity is displayed in %/DIV.

(5) **Dual Trace Display**
(a) Key in the two measurement items to be simultaneously measured at Y1 and Y2.
(b) Dual trace display of measurement items having respective different modulation frequencies, such as delay and DP measurement items for example, is impossible.

Note 2: For dual trace display including measurement of return loss, see paragraph [15].

10

BB TO BB (Link included modulator and



5

Presetting the REAR PANEL

Set the controls as follows:

TRANSMITTER:

(1)	TRANSMITTER MODE	
	BB, IF	BB.
(2)	SWEEP FREQUENCY	LINE.
(3)	SWEEP OUTPUT Vp/75Ω	Set the voltage using the following equation. $\text{Volts peak} = \frac{\text{Sweep width (HzP-P)}}{2} \times \frac{\text{test tone level of test point (Vrms/75 Ω)}}{\text{test tone deviation of test point (Hz rms)}}$ It is convenient to confirm the IF band sweep width with markers.
(4)	BB FREQUENCY	Required modulation frequency. For Linearity and Delay measurement, set the BB frequency to less than 1 MHz, for DG and DP measurement, set the BB frequency to more than 1 MHz ($\leq$8.2 MHz).
(5)	BB OUTPUT LEVEL dBm	Set level corresponds to FM deviation 200 kHz rms for Linearity and Delay measurement, or FM deviation 500 kHz rms for DG and DP measurement.
(6)	(OUTPUT SELECT)	BB + SWEEP OUTPUT

RECEIVER:

(7)	RECEIVER MODE	BB.
(8)	RANGE	AUTO.
(9)	MARKER	SLIDE. Set the frequency to observing bandwidth.
(10)	X SELECT	IF. (Refer to Note 1).
(11)	X PHASE, BLANKING	Adjusting the knob to coincide the tracing marker pulse with the retracing marker pulse while the BLANKING switch is OFF. After adjusting, set the BLANKING switch to ON.
(12)	Measurements	Push Y1, Y2 measuring keys. Do not select the AMPL and RET. LOSS keys. (If BB SWEEPER option 01 is installed, oscillation of the X axis on the CRT will stop.)

demodulator, and so forth) BB TO BB

Note 1: For end to end measurement, the horizontal-axis signal and frequency marker can be obtained by supplying the signal branched from the IF section of object being measured to the IF INPUT connector. If this branching is difficult, set the X SELECT to BB, and set MARKER of OFF. However, in this case, the BB INPUT input signal must include the sweep frequency component.

(1) **Group Delay Measurement**
(a) Y1 keys DELAY/DP.
(b) Confirm that modulation frequency is less than 1 MHz and deviation is about 200 kHz rms.
(c) Scale sensitivity is displayed in ns/DIV.

(2) **Linearity Measurement**
(a) Y1 keys LINEARITY/DG.
(b) Confirm that modulation frequency is less than 1 MHz and deviation is about 200 kHz rms.
(c) Scale sensitivity is displayed in %/DIV.

(3) **Differential Phase Measurement**
(a) Y1 keys DELAY/DP.
(b) Confirm that modulation frequency is more than 1 MHz ($\leq$8.2 MHz), and FM deviation is about 500 kHz rms.

Note 1: To convert to delay time, use the equation below:

$$\tau\,(\text{ns}) = \frac{\text{DP (degree)}}{0.36 \times \text{fm (MHz)}}$$

A conversion table fro group delay and the differential phase calculated using the above equation is given in Appendix [24].

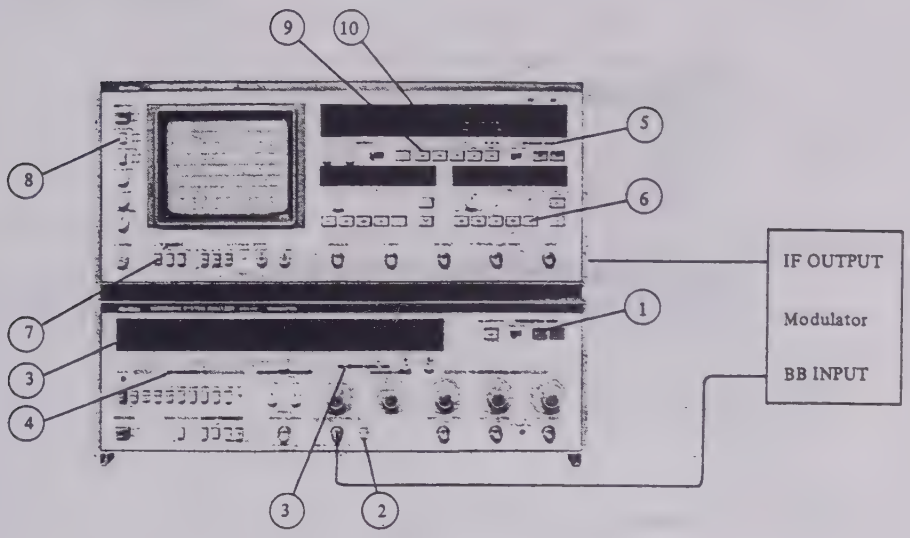
(c) Scale sensitivity is displayed in DEG/DIV.

(4) **Differential Gain Measurement**
(a) Y1 keys LINEARITY/DG.
(b) Confirm that modulation frequency is more than 1 MHz ($\leq$8.2 MHz), and FM deviation is about 500 kHz rms.
(c) Scale sensitivity is displayed in %/DIV.

(5) **Dual Trace Display**
(a) Key in the two measurement items to be simultaneously measured at Y1 and Y2.
(b) Dual trace display of measurement items having respective different modulation frequencies, such as delay and DP measurement items for example, is impossible.

Note 2: For dual trace display including measurement of return loss, see Paragraph [15].

MODULATOR SENSITIVITY



5 **Presetting the REAR PANEL**

Set the controls as follows:

TRANSMITTER:

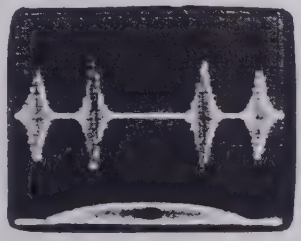
(1)	TRANSMITTER MODE	BB.
(2)	(OUTPUT SELECT)	BB OUTPUT
(3)	BB OUTPUT LEVEL dBm	–50 dBm.
(4)	BB FREQUENCY Hz	A type – 200 kHz, B type – 278 kHz, C type – 250 kHz.

RECEIVER:

(5)	RECEIVER MODE	
	IF BAND	Required band.
	BB, IF	IF.
(6)	Y2 keys	SPECTRUM.
(7)	X SELECT	IF.
(8)	BLANKING	ON.

Deviation meter calibration

(3)	BB OUTPUT LEVEL dBm	Start at –50 dBm and slowly raise the level. Stop when the spectrum image on CRT screen reaches first carrier zero. Refer to the following figure.
(9)	CAL	Push this key twice.
(10)	DEVIATION kHz rms CAL	The deviation meter is calibrated with the CAL key (10). A type – 340 kHz rms, B type – 472 kHz rms, C type – 425 kHz rms.



The first carrier zero

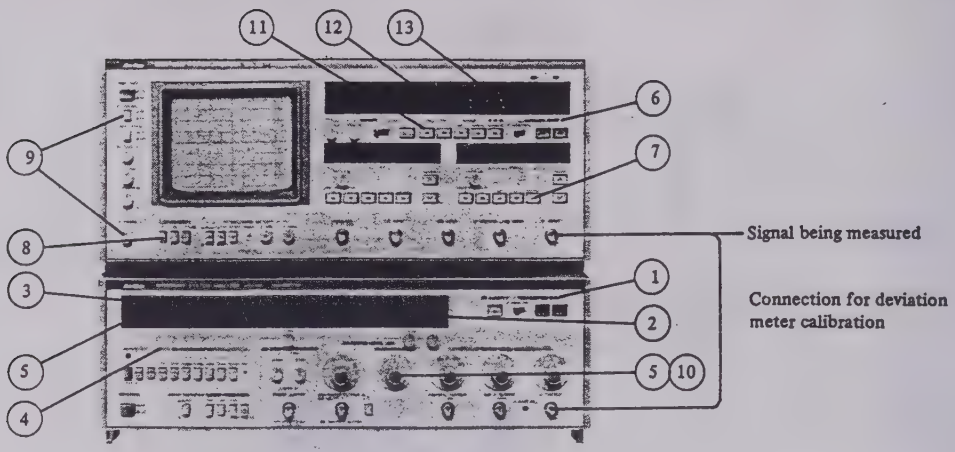
Measurement (1): At this time, read the BB OUTPUT LEVEL (3) X dBm and DEVIATION (10).

$$\text{Modulator sensitivity} = \frac{\text{DEVIATION (kHz rms)}}{\text{X (dBm)}}$$

Measurement (2): Set BB OUTPUT LEVEL (3) to test tone level, and read DEVIATION (10).

$$\text{Modulator sensitivity} = \frac{\text{DEVIATION (kHz rms)}}{\text{Test tone level (dBm)}}$$

FREQUENCY DEVIATION



5 ⇦ **Presetting the REAR PANEL**
Set the controls as follows:

(1) Calibrate the DEVIATION meter. Connect IF OUTPUT to IF INPUT by cable.

TRANSMITTER:

①	TRANSMITTER MODE	
	IF BAND	Required band.
	BB, IF	IF.
②	IF CENTER FREQ	70 MHz or 140 MHz.
③	SWEEP WIDTH ±MHz	Zero.
④	BB FREQUENCY	A type – 200 kHz, B type – 278 kHz, C type – 250 kHz.
⑤	DEVIATION kHz rms	Set the deviation to A type – 340 kHz, B type – 472 kHz rms and C type – 425 kHz rms.

RECEIVER

⑥	RECEIVER MODE	
	IF BAND	Required band.
	BB, IF	IF.
⑦	Y2 keys	SPECTRUM.
⑧	X SELECT	IF.
⑨	BLANKING	ON.
⑩	DEVIATION dial of TRANSMITTER	Readjust the DEVIATION kHz rms dial of the TRANSMITTER to get the first carrier zero spectrum on the CRT screen.
⑪	CAL	Push this key twice.
⑫	DEVIATION kHz rms CAL	The deviation meter is calibrated with the CAL key ⑪.

(2) Measurement, Input the unknown deviation signal to the IF INPUT terminal.
Deviation is directly displayed on the panel ⑫.

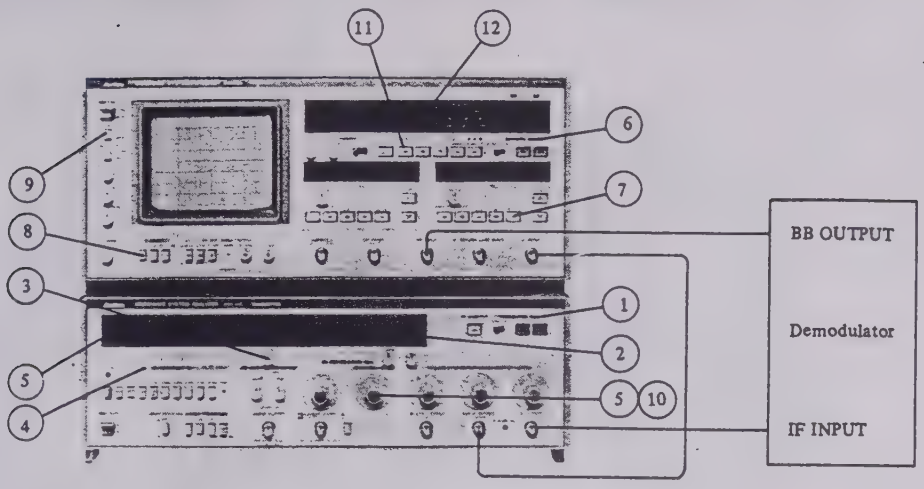
Note: Measurement accuracy ① When modulation frequencies are 200 kHz, 278 kHz or 250 kHz and BB FREQUENCY Hz LED ⑬ is lit, the error is exceedingly small.

Measurement accuracy ② When BB FREQUENCY Hz LED ⑬ except 200 kHz, 278 kHz or 250 kHz is lit, the error is less than 10 %.

Measurement accuracy ③ Pay attention to the accuracy in the deviation measurement of the other modulation frequencies (80 kHz $\leq$ fm $\leq$ 8.2 MHz) which are not built in this equipment, because error is not so high in this case.

13

DEMODULATOR SENSITIVITY



5

Presetting the REAR PANEL

Set the controls as follows:

(1) Calibrate the DEVIATION of TRANSMITTER as follows.

TRANSMITTER:

①	TRANSMITTER MODE	
	IF BAND	Required band.
	BB, IF	IF.
②	IF CENTER FREQ	70 MHz/140 MHz.
③	SWEEP WIDTH ±MHz	Zero.
④	BB FREQUENCY	A type – 200 kHz, B type – 278 kHz, C type – 250 kHz.
⑤	DEVIATION kHz rms	Set the deviation to A type – 340 kHz rms, B type – 472 kHz rms and type – 425 kHz rms.

RECEIVER:

⑥	RECEIVER MODE	
	IF BAND	Required band.
	BB, IF	IF.
⑦	Y2 keys	SPECTRUM.
⑧	X SELECT	IF.
⑨	BLANKING	ON.
⑩	DEVIATION dial of TRANSMITTER	Readjust the DEVIATION kHz rms dial of the TRANSMITTER to ge the first carrier zero spectrum on CRT screen.
⑪	CAL	Push this key twice.
⑫	DEVIATION kHz rms CAL	The deviation meter is calibrated with the CAL key ⑪.

(2) Measurement A

(1) Read DEVIATION ⑫ . . . . . .X Hz rms.
(2) Push RECEIVER MODE ⑥ . . . . . .BB.
(3) Read INPUT LEVEL dBm ⑫ . . . . . .Y dBm.
(4) Calculate the demodulator sensitivity with the following equation.

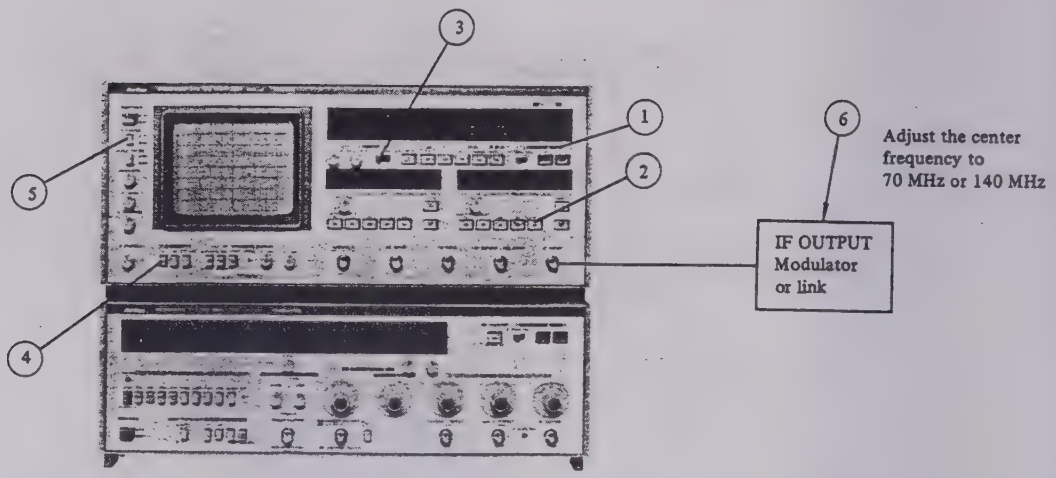
$$\text{Demodulator Sensitivity} = \frac{\text{BB level Y (dBm)}}{\text{Deviation X (Hz rms)}}$$

(3) Measurement B

(1) Set the DEVIATION ⑫ to test tone deviation (ex. 140 kHz rms or 200 kHz rms).
(2) Push RECEIVER MODE ⑥ . . . . . .BB.
(3) Read INPUT LEVEL dBm ⑫ . . . . . .Y dBm.
(4) Calculate the demodulator sensitivity with the following equation.

$$\text{Demodulator Sensitivity} = \frac{\text{BB level (dBm)}}{\text{Test tone deviation (Hz rms)}}$$

FREQUENCY ADJUSTMENT
(Center Frequency of Modulator and IF signal)



5 **Presetting the REAR PANEL**

Set the controls as follows:

RECEIVER:

(1) RECEIVER MODE

IF BAND — Required band.

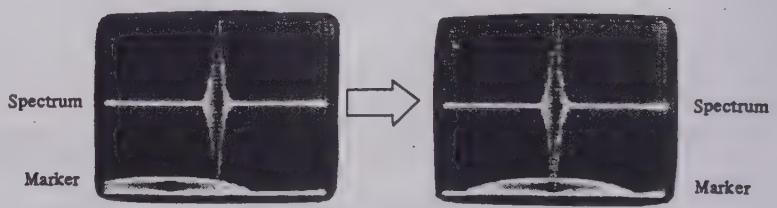
(2) Y2 keys — SPECTRUM.

(3) MARKER — SLIDE. 70 MHz/140 MHz Marker appears.

(4) X SELECT — IF.

(5) BLANKING — ON.

(6) Adjust the Center frequency controller of the object being measured to 70 MHz or 140 MHz, as shown below.



70 MHz or 140 MHz Marker — 70 MHz or 140 MHz Marker

Before adjustment — The frequency of the object being measured is adjusted correctly

Note 1: When the IF INPUT signal is not 70 ±0.7 MHz, use the slide marker and read the frequency as follows:

- o Align the positions of the spectrum and the slide marker with the MARKER FREQUENCY controller.
- o Read the slide marker frequency on the LED display at this time.
- o Obtain the input signal frequency from the center marker frequency fo (70 MHz or 140 MHz) and the slide marker frequency fs as follows:

Turn the MARKER FREQUENCY controller counterclockwise:

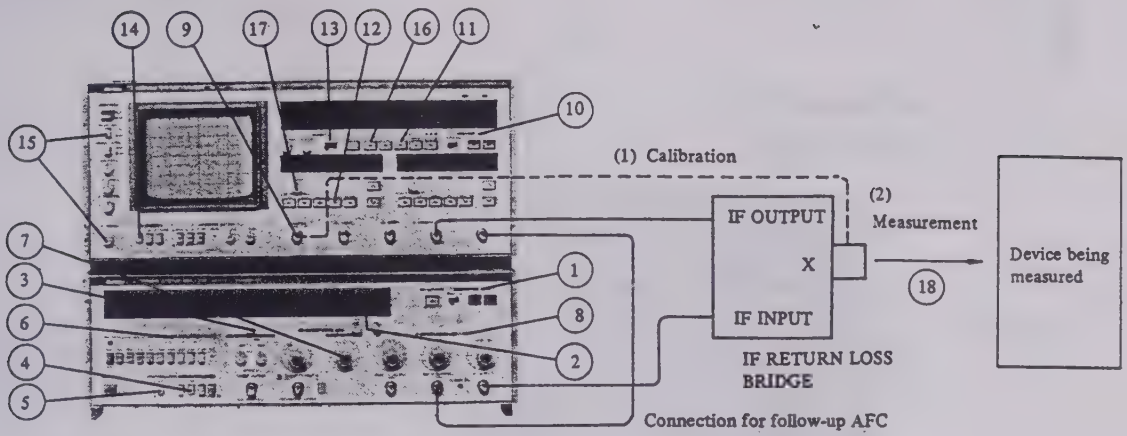
(a) If the marker waveform on the CRT moves from left to right: Input frequency = fo − fs.

(b) If the marker waveform on the CRT moves from right to left: Input frequency = fo + fs.

Note 2: The usage range is correct if the slide marker frequency shown on the LED display increases when the frequency controller is turned clockwise. If the frequency decreases, continue turning the frequency controller clockwise until zero frequency is passed. This will result in the correct position.

15

IF RETURN LOSS



5

Presetting the REAR PANEL
Set the controls as follows:

(1) Calibration of RETURN Loss indicator.

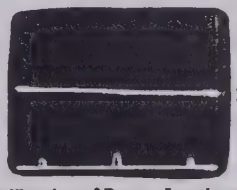
TRANSMITTER:

①	TRANSMITTER MODE		
	IF BAND	Required band.	
	BB, IF	IF.	
②	IF CENTER FREQ	70 MHz or 140 MHz.	
③	SWEEP WIDTH	Required bandwidth.	
④	SWEEP FREQUENCY	LINE.	
⑤	SWEEP REDUCTION	OFF.	
⑥	BB FREQUENCY Hz	Less than 1 MHz	These setting are not needed theoretically, but are effective for eceiver stability.
⑦	DEVIATION kHz rms	200 kHz rms of less	
⑧	IF OUTPUT LEVEL dBm	+10 dBm.	

⑨ Connect the X terminal of the RETURN LOSS BRIDGE to MISSMATCH 20 dB terminal for calibration.

RECEIVER:

⑩	RECEIVER MODE	
	IF BAND	Required band the ssame as TRANSMITTER.
	BB, IF	IF.
⑪	RANGE	AUTO.
⑫	Y1 keys	RET LOSS
⑬	MARKER	SLIDE. Set the required band.
⑭	X SELECT	IF.
⑮	X PHASE, BLANKING	Adjust the knob to coincide the tracing marker image with the retracing marker image while the BLANKING switch is OFF. After adjusting, set the BLANKING switch to ON.
⑯	CAL	Push this key twice. The calibration factor 20 dB is displayed on Y1 panel display.
⑰	POSITION	Adjust the 20 dB return loss image on CRT to the center of the Y axis scale as shown below.



Calibration of Return Loss image

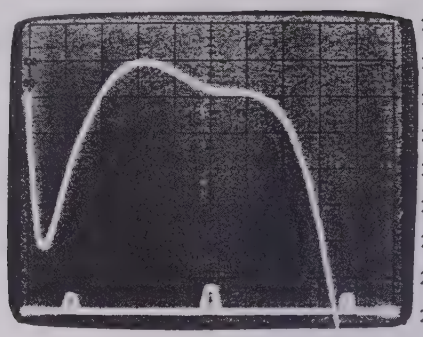
(2) Measurement

⑱ Connect the X terminal of the RETURN LOSS BRIDGE to the device being measured.

IF RETURN LOSS

Measurement Example

RANGE – AUTO

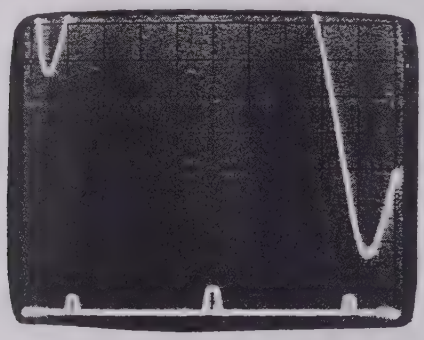


When RANGE (11) is set to AUTO, the center value of the scale is displayed on the Y1 panel display automatically by measuring results.

The marker frequency (13) is set to ±10 MHz.

Fig. A

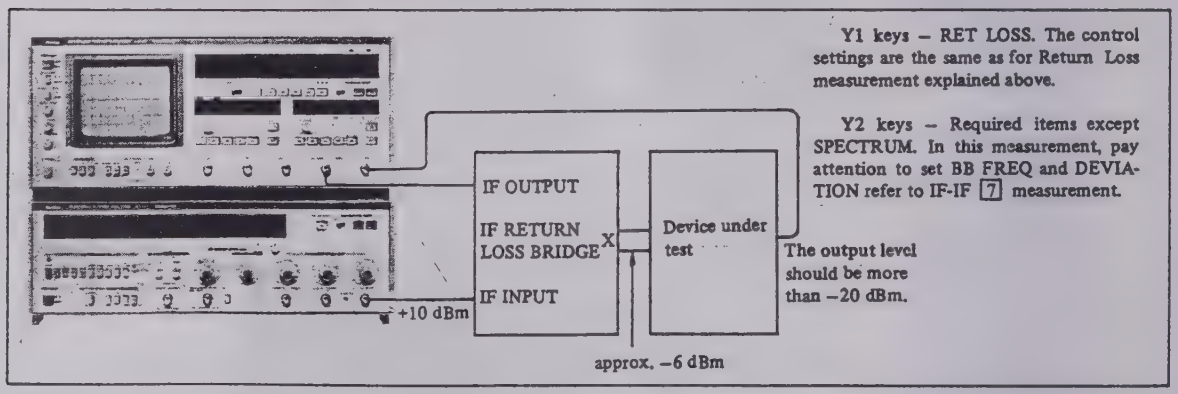
RANGE – MANUAL



When RANGE (11) is set to MANUAL, the center value of the scale and the displayed center value on the Y1 panel display. Can be changed by the RANGE keys as shown in Fig. B.

Fig. B

Dual Trace Display Included IF Return Loss Characteristic

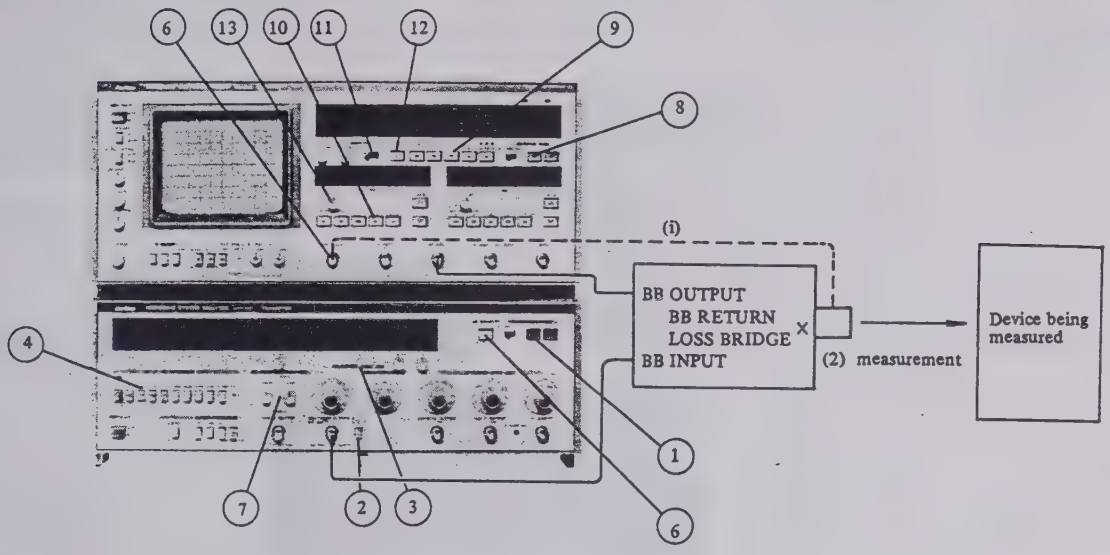

IF OUTPUT
IF RETURN LOSS BRIDGE
X
IF INPUT
+10 dBm
Device under test
approx. –6 dBm
Y1 keys – RET LOSS. The control settings are the same as for Return Loss measurement explained above.
Y2 keys – Required items except SPECTRUM. In this measurement, pay attention to set BB FREQ and DEVIATION refer to IF-IF 7 measurement.
The output level should be more than –20 dBm.

Changing the 20 dB calibration factor.

If a standard terminater which has a severe value is prepared for use instead of the built-in 20 dB mismatch, the factor can be changed as follows:

(i) Connect the X terminal of the IF RETURN LOSS BRIDGE to the standard value terminater.
(ii) CAL (16) – Push. The LED is lit.
(iii) Adjust the numerical value of the Y1 panel display to the standard value using the RANGE keys ⌃ ⌄.
(iv) CAL (16) – Push. The LED is extinguished.
(v) Measurement – Connect the X terminal of the IF RETURN LOSS BRIDGE to the device being measured.

BB RETURN LOSS



5 ⇐ **Presetting the REAR PANEL**

Set the controls as follows:

(1) Point-by-point measurement.

TRANSMITTER:

(1)	TRANSMITTER MODE	BB.
(2)	(OUTPUT SELECT)	BB OUTPUT
(3)	BB OUTPUT LEVEL dBm	+10 dBm.
(4)	BB FREQUENCY	Desired frequency.

RECEIVER:

(5)	RECEIVER MODE	BB.

Measurement

(i) Connect the X terminal of the BB RETURN LOSS BRIDGE to MISMATCH 20 dB (6).
(ii) Read the BB LEVEL dBm ..... X dBm.
(iii) Connect the X terminal of the BB RETURN LOSS BRIDGE to the device being measured.
(iv) Read the BB LEVEL dBm ..... Y dBm.
(v) Calculation

$$\text{Return Loss} = X - Y + 20 \text{ (dB)}$$

(2) Measurement used BB SWEEPER Function (Option).

TRANSMITTER:

(6)	BB SWEEPER	Push.
(2)	BB OUTPUT SELECT	BB.
(3)	BB OUTPUT LEVEL dBm	+5 dBm
(7)	BB SWEEPER FREQUENCY	After setting the RECEIVER controls, adjust the START, STOP knob while observing the Marker line on the CRT.

RECEIVER:

(8)	RECEIVER MODE	BB.
(9)	RANGE	AUTO.
(10)	Y1 keys	RET LOSS.

BB RETURN LOSS

(11)	MARKER	SLIDE or 2 MHz COMB + SLIDE. (Do not use these markers, other markers appear as in the following Fig. A).
(i)	Connect the X terminal of the BB RETURN LOSS BRIDGE to MISMATCH 20 dB terminal (6).	
(12)	CAL	Push the key twice. Calibration factor 20 dB is displayed on Y2 panel indicator.
(13)	POSITION	Shift the 20 dB return loss image on the CRT to the center of the Y axis scale as in the following Fig. A.

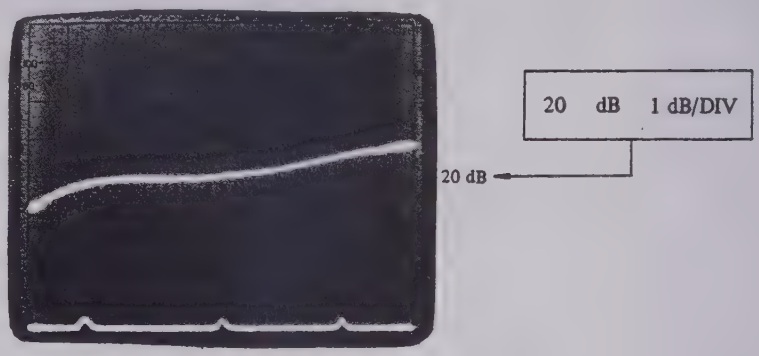


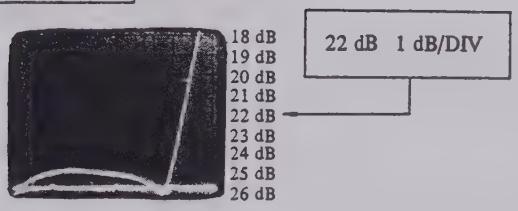
Fig. A

Measurement

Connect the X terminal of BB RETURN LOSS BRIDGE to the device being measured.

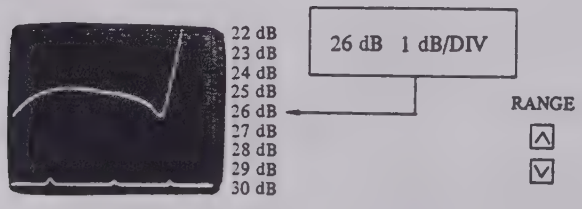
Measurement Example

RANGE – AUTO



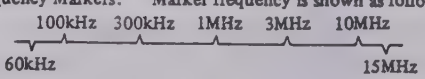
When RANGE (9) is set to AUTO, the center value of the scale is displayed on Y1 panel automatically by measuring result.

RANGE – MANUAL



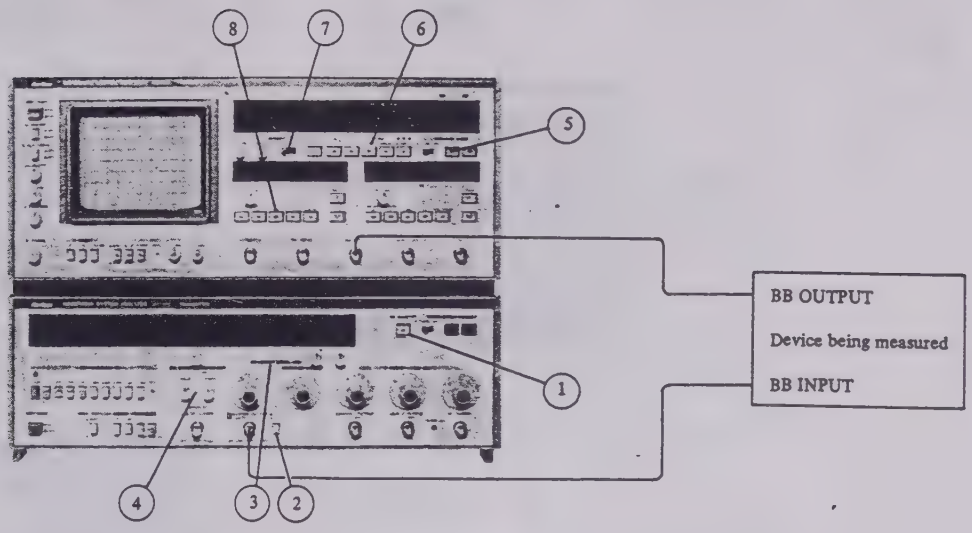
When RANGE (9) is set to MANUAL, the center value of the scale and the displayed center value on the Y1 panel can be changed by the RANGE keys as in Fig. C.

Frequency Markers: Marker frequency is shown as follows.



17

BB TO BB AMPLITUDE RESPONSE



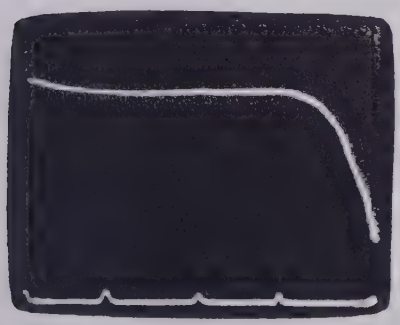
5 ⇐ **Presetting the REAR PANEL**

Set the controls as follows:

	TRANSMITTER:	
(1)	BB SWEEPER	Push.
(2)	(OUTPUT SELECT)	BB OUTPUT ⎓
(3)	BB OUTPUT LEVEL dBm	Required level.
(4)	BB SWEEPER FREQUENCY	Adjust the START, STOP knob while observing the Marker line on the CRT after setting the RECEIVER controls.
	RECEIVER:	
(5)	RECEIVER MODE	BB.
(6)	RANGE	AUTO.
(7)	MARKER	SLIDE or 2 MHz COMB + SLIDE.
(8)	Y1 or Y2 keys	AMPL.
	Measurement.	

Measurement Example

RANGE – AUTO



1.0 dB/DIV

RANGE can be set to MANUAL to change the Y axis sensitivity, when the sensitivity is not suitable for measurement.

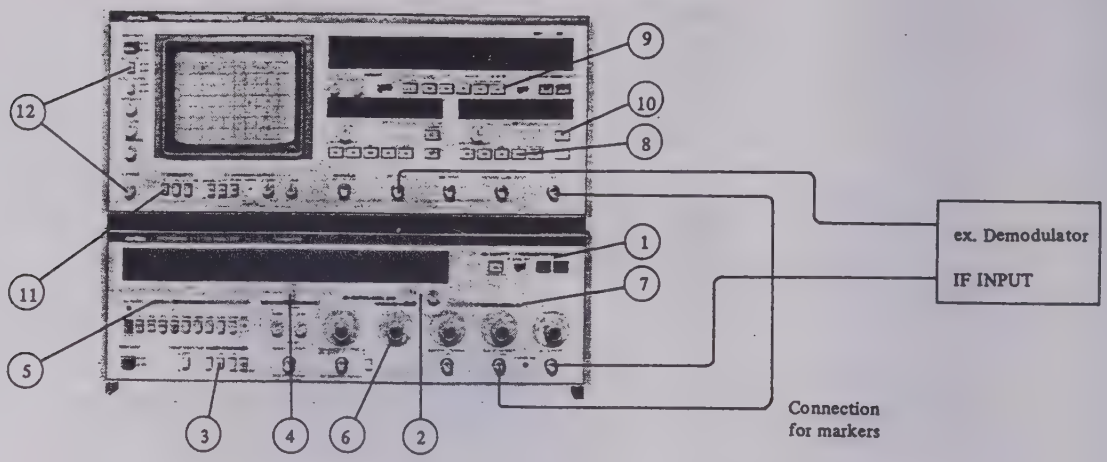
Note: Marker frequencies

100kHz 300kHz 1MHz 3MHz 10MHz

60kHz 15MHz

Note: If the amplitude characteristic of the device being measured is larger than about 15 dB, the X axis and the markers cannot be regenerated on the CRT. In this case, the swept band should be narrowed by START and STOP knobs.

DC CHARACTERISTIC
(ex. S curve of demodulator)



5 ⇦ **Presetting the REAR PANEL**

Set the controls as follows (ex. S curve characteristic of demodulator):

TRANSMITTER:

(1)	TRANSMITTER MODE		
	IF BAND	Required band.	
	BB, IF	IF.	
(2)	IF CENTER FREQ	70 MHz or 140 MHz.	
(3)	SWEEP FREQUENCY	LINE.	
(4)	SWEEP WIDTH	Required sweep width.	
(5)	BB FREQUENCY	Less than 1 MHz	These settings are not needed theoretically, but are effective for Receiver stability.
(6)	DEVIATION	200 kHz rms or less	
(7)	IF OUTPUT LEVEL dBm	Required level.	

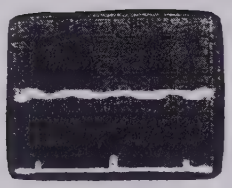
RECEIVER:

(8)	Y2 keys	DC.
(9)	RANGE	MANUAL.
(10)	The sensitivity of the CRT can be changed by these RANGE keys.	
(11)	X SELECT	IF or EXT/LINE.
(12)	X PHASE, BLANKING	Adjust the knob to coincide the tracing image with the re-tracing image while the BLANKING switch is OFF. After adjustment, push the BLANKING switch ON.

Measurement.

AM-PM CONVERSION COEFFICIENT

Residual PM.

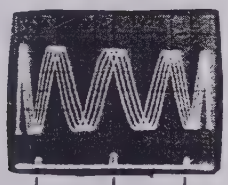


0.2 °/dB /DIV

Note: If the deviation display of the Receiver is out of 190 to 209 kHz rms. AM-PM conversion COEFFICIENT measurement facility does not function.

Fig. a

Measurement example



0.2 °/dB /DIV

60 MHz 70 MHz 80 MHz

Fig. b

AM-PM CONVERSION COEFFICIENT

—STANDARD GROUP DELAY NETWORK METHOD—

If a Parabolic Delay Network is inserted into the circuit in front of the object being measured as shown in Fig. (1), 1st order slope of differential gain is generated by the 1st order AM-PM conversion coefficient $\phi 1$ of the object being measured, and the measured value will vary. Therefore, from the amount of this variation, $\phi 1$ can be derived.

$$\phi 1 = \frac{dp1}{2fd^2 \cdot \pi \cdot \gamma_2} \text{ (radian)}$$

where,

dp1 = 1st order coefficient of differential gain (1/Hz)
fd = differential frequency (Hz)
γ_2 = parabolic group delay coefficient (sec/Hz^2)

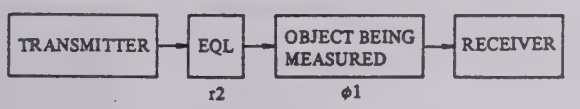


Figure (1) AM-PM Conversion Coefficient Measurement According to Standard Group-Delay Network Method

However, the Parabolic Delay Network also has differential gain characteristics, as shown in Fig. (2) (a), so it is necessary to be careful when reading the 1st order slope from the differential gain component.

a) Differential gain characteristics of Parabolic Delay Network

b) Differential gain characteristics from (ϕ1)

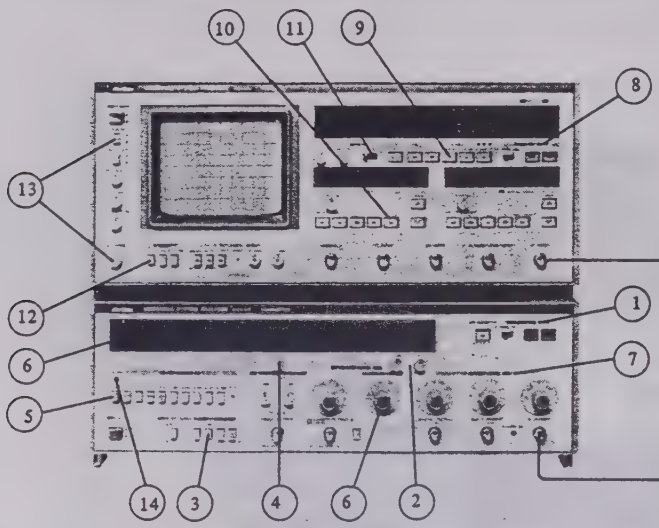
c) Differential gain characteristics component added to differential gain characteristics of the object to be measured.

Fig. (2) Differential Gain Measurement Image

19

AM-PM CONVERSION COEFFICIENT

—AM METHOD—



(1) Connection for adjusting the minimum residual AM-PM conversion value.

(2) Measurement

OUTPUT

Object being m

INPUT

5 ⇐ **Presetting the REAR PANEL**

Set the controls as follows:

(1) Calibration –Minimize the residual AM-PM conversion value.

Connect IF OUTPUT terminals to IF INPUT terminal directly.

TRANSMITTER:

①	TRANSMITTER MODE	
	IF BAND	Required band.
	BB, IF	IF.
②	IF CENTER FREQ	70 MHz or 140 MHz.
③	SWEEP FREQUENCY	LINE.
④	SWEEP WIDTH ±MHz	Required sweep width.
⑤	AM-PM	Push. (i) IF OUTPUT signal is AM and FM modulated. (ii) The modulation frequencies are A type – 200 kHz, B type – 278 kHz, C type – 250 kHz. (iii) The AM modulation frequencies are a little larger (500 Hz) than FM modulation frequencies.
⑥	DEVIATION kHz rms	Set the DEVIATION display of Receiver to 200 kHz rms (within 190 to 209 kHz)
⑦	IF OUTPUT LEVEL dBm	Required level (–20 dBm to +10 dBm)

RECEIVER:

⑧	RECEIVER MODE	
	IF BAND	Required band the same as TRANSMITTER.
	BB, IF	IF.
⑨	RANGE	AUTO.
⑩	Y1 keys	AM-PM.
⑪	MARKER	SLIDE.
⑫	X SELECT	IF.
⑬	X PHASE BLANKING	Adjust the knob to coincide the tracing marker signal with the re-tracing marker signal while the BLANKING switch is OFF.
⑭	AM-PM ADJ	Minimize the amplitude of the beat wave by adjusting this knob, when the amplitude (peak to peak) is more than 0.3°/dB, as shown in Fig. a.

(2) Measurement.

Connect IF OUTPUT and IF INPUT to the device being measured.

⑦	IF OUTPUT LEVEL dBm	Required level.

MEASUREMENT FOR COMMUNICATIONS SATELLITES

IMPROVEMENT OF THRESHOLD LEVEL (For the signal of small C/N ratio)

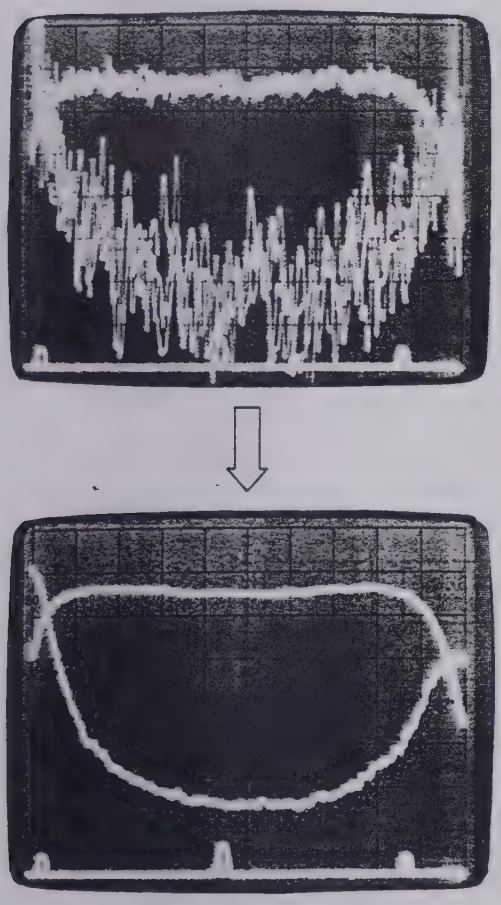
When the THRESHOLD EXTENSION switch on rear panel of the receiver is ON, a narrow bandpass filter is inserted into the circuit and the threshold is improved (equivalent C/KT: 73 dB at noise band less than 30 MHz). But in this case the BB frequency must be 556 kHz or less.

S/N IMPROVEMENT ON CRT

The receiving signal through satellite Links include large amount of noise. Therefore the measuring result on the CRT has too much noise.

In this case, the NORMLZR (Normalizer) function of the RECEIVER is effective for noise reduction on the CRT by employing signal averaging technics.

Details on NORMLZR functions are explained on page 4.

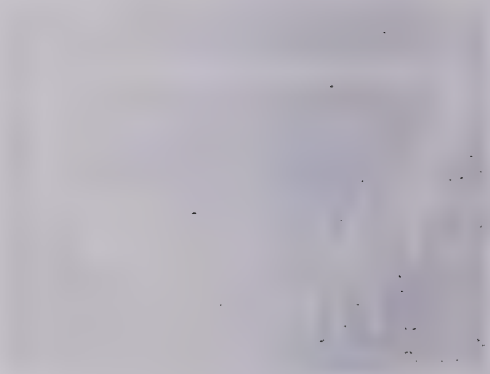


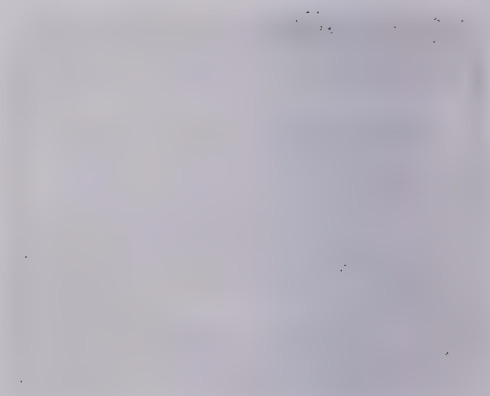
LIMITATION OF MODULATING BB FREQUENCY AND FM DEVIATION

When measure a narrow bandpass filter for example, 2.5 MHz, it is necessary to conduct the measurement with the BB frequency at 100 kHz or less, and the frequency deviation as low as possible (for example, 50 to 100 kHz rms).

STABLE OPERATION OF CRT HORIZONTAL AXIS

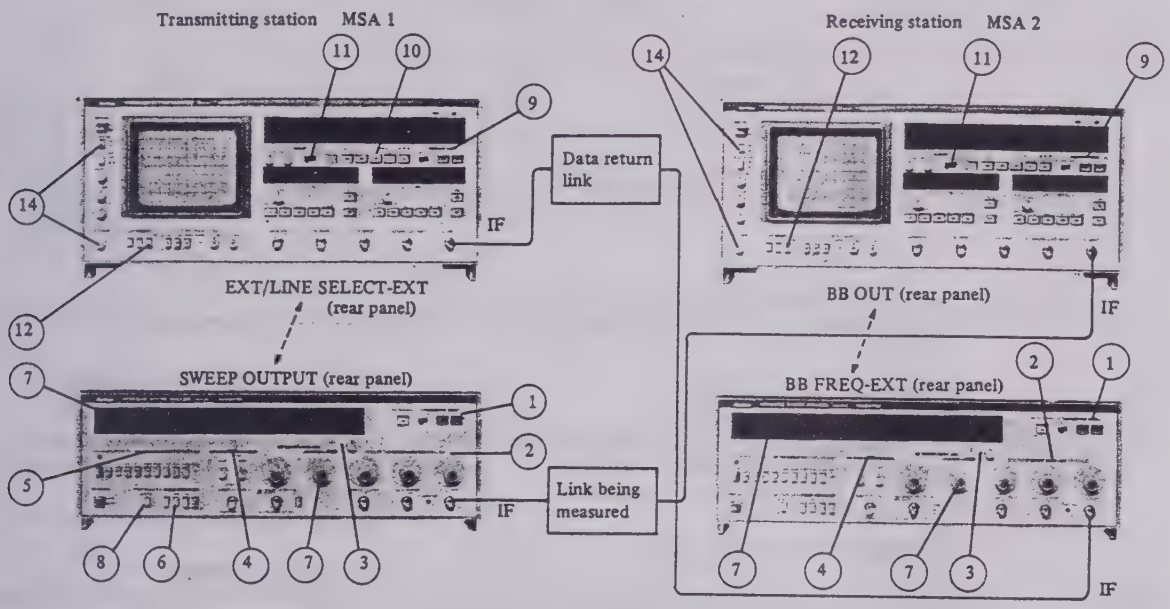
When the SWEEP OUTPUT terminal on the rear panel of the transmitter is connected to the EXT/LINE SELECT-EXT terminal on the rear panel of the receiver, the horizontal axis will operate stably even if the IF sweep width is narrow.





REMOTE MONITORING

Remote monitoring is used to transfer the value measured at a receiving station MSA2 (Microwave System Analyzer 2) to the receiver at the transmitting station MSA1 (Microwave System Analyzer 1).



Set the MSA1 and MSA2 controls as follows:

Controls	MSA1	MSA2
Rear Panel (Refer to page 5).		
PLL CUT FREQ	HIGH.	HIGH.
CRT TRACE	CHOP.	CHOP.
THRESHOLD EXTENSION	OFF.	OFF.
MARKER SELECT	INT.	INT.
Connection	Connect SWEEP OUTPUT of transmitter to EXT/LINE SELECT-EXT of Receiver.	Connect BB OUTPUT of Receiver to BB FREQ SELECT-EXT of Transmitter.
Front Panel		
TRANSMITTER		
① TRANSMITTER MODE		
IF BAND BB, IF	Required band. IF.	Required band. IF.
② IF OUTPUT LEVEL dBm	Required level.	Required level.
③ IF CENTER FREQ	70 MHz or 140 MHz.	70 MHz or 140 MHz.
④ SWEEP WIDTH	Required sweep width.	Zero.
⑤ BB FREQUENCY	Required frequency.	–
⑥ SWEEP FREQUENCY	Line or others.	–
⑦ DEVIATION kHz rms	200 kHz rms (BB frequency <1 MHz) or 500 kHz rms (BB frequency >1 MHz)	200 kHz rms (BB frequency <1 MHz) or 500 kHz rms (BB frequency >1 MHz)
⑧ SWEEP REDUCTION	If required, set to ON.	–

REMOTE MONITORING

Controls	MSA1	MSA2	
Front Panel			
RECEIVER			
⑨ RECEIVER MODE			
IF BAND	Required band.	Required band.	
BB, IF	IF.	IF.	
⑩ RANGE	AUTO.	AUTO.	
⑪ MARKER	OFF.	SLIDE.	
⑫ X SELECT	EXT/LINE.	IF.	These settings are not necessary for data return.
⑬ Y1 or Y2 selectors	Required item as follows.	Required item as follows.	
⑭ X PHASE BLANKING	Coincide the trace and re-trace images with BLANKING OFF.	Coincide the trace and re-trace image with BLANKING OFF.	
Measurement			

(1) Group Delay Measurement

(a) Y1 keys DELAY/DP.

(b) Confirm that modulation frequency is less than 1 MHz and deviation is about 200 kHz rms.

(c) Scale sensitivity is displayed in ns/DIV.

(2) Differential Phase Measurement

(a) Y1 keys DELAY/DP.

(b) Confirm that modulation frequency is more than 1 MHz ($\leqq$8.2 MHz), and FM deviation is about 500 kHz rms.

Note: To convert to delay time, use the equation below:

$$\tau\,(\text{ns}) = \frac{\text{DP (degree)}}{0.36 \times \text{fm (MHz)}}$$

A conversion table for group delay and the differential phase calculated using the above equation is given in Appendix

(c) Scale sensitivity is displayed in DEG/DIV.

(3) Differential Gain Measurement

(a) Y1 keys LINEARITY/DG.

(b) Confirm that modulation frequency is more than 1 MHz ($\leqq$8.2 MHz), and FM deviation is about 500 kHz rms.

(c) Scale sensitivity is displayed in %/DIV.

(4) Dual Trace Display

(a) Key in the two measurement items to be simultaneously measured at Y1 and Y2.

(b) Dual trace display of measurement items having respective different modulation frequencies, such as delay and DP measurement items for example, is impossible.

Note: For dual trace display including measurement of return loss, see Paragraph 15.

Note: The remote monitoring function is applicable only to group delay, differential gain and differential phase measurements because the receiving BB signal is returned to the transmitting station with a no-sweep carrier.

SPECIFICATIONS

Measurements

Items \ Models		ME453A/B/C	ME538A/B/C	
		70 MHz Band	70 MHz Band	140 MHz Band
Amplitude (IF INPUT terminal)	Inherent Slope	±0.05 dB/±25 MHz	±0.05 dB/±25 MHz	±0.05 dB/±25 MHz, ±0.1 dB/ ±40 MHz, ±0.2 dB/±50 MHz
	Measuring Range	0 to 16 dB		
	Max Sensitivity	0.01 dB/DIV (at Y2 Display)		
	IF INPUT Level	+10 to −20 dBm		
Amplitude (RET. LOSS INPUT terminal)	Inherent Slope	±1 dB		
	Measuring Range	0 to 8 dB		
	Sensitivity	1 dB/DIV		
	INPUT Level	−60 to −20 dBm		
Group Delay	Inherent Slope	0.3 ns/±15 MHz, 0.5 ns/ ±25 MHz	0.3 ns/±15 MHz, 0.5 ns/ ±25 MHz	0.3 ns/±20 MHz, 0.5 ns/±30 MHz, 1 ns/±50 MHz
	Measuring Range	0 to 400 ns		
	Max Sensitivity	0.1 ns/DIV (at Y2 Display)		
	Noise	0.01 ns/Condition; f_M = 200 kΩ ~ 278 kHz, Deviation 200 kHz rms, Using Average function.		
Linearity	Inherent Slope	0.2%/±25 MHz	0.2 %/±25 MHz	0.2 %/±50 MHz
	Measuring Range	0 to 80 %		
	Max Sensitivity	0.05 %/DIV		
	Noise	0.005 %/Condition, f_M <1 MHz, Deviation 200 kHz rms, Using Average function.		
Differential Phase	Inherent Slope*1	0.3°/±15 MHz, 0.5°/±25 MHz	0.3°/±15 MHz, 0.5°/±25 MHz	0.3°/±20 MHz, 0.5°/±30 MHz, 0.8°/ ±50 MHz
	Measuring Range	0 to 40°		
	Max Sensitivity	0.2°/DIV		
	Noise	0.02°/Condition, f_M = 5.6 MHz, Deviation 500 kHz rms, Using Average function.		
		*1: Specified frequency range = Carrier sweep width + 2 f_M		
Differential Gain	Inherent Slope*2	0.2 %/±15 MHz, 0.4 %/ ±25 MHz	0.2 %/±15 MHz, 0.4 %/ ±25 MHz	0.3 %/±20 MHz, 0.4 %/±30 MHz, 0.6 %/±50 MHz
	Measuring Range	0 to 80 %		
	Max Sensitivity	0.05 %/DIV		
	Noise	0.01 %/Condition, f_M = 5.6 MHz, Deviation 500 kHz rms, Using Average function		
		*2: Specified frequency range = Carrier sweep width + 2 f_M		
IF Return Loss	Frequency Range	70 ±25 MHz	70 ±25 MHz	140 ±50 MHz
	Measuring Range	10 to 50 dB accuracy depends on using bridge.		
	Sensitivity	1 dB/DIV		
AM to PM Conversion	Residual PM	0.3°/dB/±25 MHz	0.3°/dB/±25 MHz	0.3°/dB/±35 MHz
	Measuring Range	0.3°/dB to 16°/dB		
Spectrum	Center Frequency	70 ±20 MHz Auto tuning	70 ±20 MHz Auto tuning	140 ±30 MHz Auto tuning
	Sweep Width	Approx. ±700 kHz		
	Max Sensitivity	Detects 0.1 dB change of modulating signal at carrier zero point.		
	Deviation	A type – 340 kHz rms at 200 kHz, B type – 472 kHz rms at 277.778 kHz, C type – 425 kHz rms at 250 kHz.		

SPECIFICATIONS

<table>
<tr><td rowspan="3">Deviation</td><td>Measuring Range</td><td colspan="4">20 kHz to 999 kHz rms at built-in BB frequencies ≦ 8.2 MHz.</td></tr>
<tr><td>Accuracy</td><td colspan="4">10 % at built-in BB frequency ≦ 8.2 MHz.</td></tr>
<tr><td>Calibration</td><td colspan="4">Deviation meter is calibrated by easy key operation. Accuracy reaches 1 % theoretically at specified modulation frequency. Deviation is as shown in the following table by Bessel zero method.
<table>
<tr><th>Model</th><th>Modulation freq.</th><th>Key in factor</th></tr>
<tr><td>A type</td><td>200 kHz</td><td>340 kHz rms</td></tr>
<tr><td>B type</td><td>277.778 kHz</td><td>472 kHz rms</td></tr>
<tr><td>C type</td><td>250 kHz</td><td>425 kHz rms</td></tr>
</table></td></tr>
<tr><td rowspan="2">Modulator Sensitivity</td><td>Mod Signal Level</td><td colspan="4">−50 to +10 dBm</td></tr>
<tr><td>Deviation</td><td colspan="4">Use the DEVIATION meter function or use the carrier zero deviation with the SPECTRUM function.</td></tr>
<tr><td rowspan="2">De-modulator Sensitivity</td><td>IF Signal</td><td colspan="4">Calibrate the deviation with DEVIATION meter function or SPECTRUM function.</td></tr>
<tr><td>Demo BB Level</td><td colspan="4">−50 to +10 dBm</td></tr>
<tr><td colspan="2">DC Input</td><td colspan="4">Measuring Range: 0 to ±400 mV, Max Sensitivity: 1 mV/DIV</td></tr>
<tr><td rowspan="6">BB to BB</td><td>Items</td><td>Inherent Slope</td><td>Measuring Range</td><td>Max Sensitivity</td><td>Noise</td></tr>
<tr><td>Group Delay</td><td>0.1 ns</td><td>0 to 400 ns</td><td>0.1 ns/DIV (at Y2)</td><td>0.2 ns</td></tr>
<tr><td>Linearity</td><td>0.1 %</td><td>0 to 80 %</td><td>0.05 %/DIV</td><td>0.05 %</td></tr>
<tr><td>Differential Phase</td><td>0.1 °</td><td>0 to 40°</td><td>0.2°/DIV</td><td>0.05 °</td></tr>
<tr><td>Differential Gain</td><td>0.1 %</td><td>0 to 80 %</td><td>0.05 %/DIV</td><td>0.05 %</td></tr>
<tr><td>Measuring Condition</td><td colspan="4">BB level; −30 dBm.</td></tr>
<tr><td rowspan="3">BB Return Loss</td><td rowspan="2">Frequency</td><td colspan="4">Built-in BB frequencies.</td></tr>
<tr><td colspan="4">100 kHz to 13 MHz (sweeping method. BB AMPLITUDE option must be designated).</td></tr>
<tr><td>Measuring Range</td><td colspan="4">10 to 47 dB (Replacement from BB level), 10 to 40 dB (BB AMPLITUDE option), accuracy depends an bridge to be used.</td></tr>
<tr><td>Sensitivity</td><td colspan="4">1 dB/DIV (BB AMPLITUDE option).</td></tr>
<tr><td rowspan="9">Input/ Output</td><td colspan="2">Items</td><td>Level Range</td><td>Level Accuracy</td><td>Impedance</td><td></td></tr>
<tr><td colspan="2">IF Input</td><td>+10 to −20 dBm</td><td>±0.3 dB (+4 dBm)</td><td>75 Ω,
>30 dB (+4 dBm)</td><td>Demodulation freq.:
66.6 kHz, 80 k to 8.2 MHz</td></tr>
<tr><td colspan="2">IF Output</td><td>+10 to −70 dBm</td><td>±0.3 dB (+4 dBm)</td><td>75 Ω,
>30 dB (+4 dBm)</td><td>Modulation frequency:
66.6 kHz to 12.39 MHz</td></tr>
<tr><td colspan="2">BB Input</td><td>+10 to −50 dBm</td><td>±0.3 dB (0 dBm)</td><td>75 Ω,
>28 dB (0 dBm)</td><td>Frequency:
66 kHz to 15 MHz</td></tr>
<tr><td rowspan="2">BB + SWEEP Output</td><td>BB</td><td>+10 to −50 dBm</td><td>±0.3 dB (0 dBm)</td><td>75 Ω,
>28 dB (−10 dBm)</td><td>Frequency:
66 kHz to 13 MHz</td></tr>
<tr><td>SWEEP</td><td>0 to 6.5 Vp-p/75 Ω</td><td>±10 % (6 Vp-p)</td><td>75 Ω</td><td>Frequency: 18 to 100 Hz</td></tr>
<tr><td colspan="2">SWEEP Output</td><td>0 to 25 Vp-p/10 kΩ</td><td>±10 % (24 Vp-p)</td><td>——</td><td>Frequency: 18 to 100 Hz</td></tr>
<tr><td colspan="2">AUX IF Output</td><td>−10 dBm</td><td>±1 dB</td><td>75 Ω</td><td></td></tr>
<tr><td colspan="2">X'tal Output</td><td>+5 dBm</td><td>±1 dB</td><td>75 Ω</td><td>Frequency: 70, 70/140 MHz</td></tr>
<tr><td colspan="2">BB Amplitude (Option)</td><td colspan="4">Frequency Range: 100 kHz to 13 MHz, level: +10 to −50 dBm, Inherent Slope: ±0.5 dB/100 kHz to 13 MHz.
Measuring Range: 0 to 8 dB, Max. Sensitivity: 0.1 dB/DIV.</td></tr>
<tr><td colspan="2">Power</td><td colspan="4">** V ±10 %, 50/60 Hz, ≦ 220 VA</td></tr>
<tr><td colspan="2">Dimension and Weight</td><td colspan="4">Receiver: 177 H, 426 W, 450 Dmm ≦ 18.5 kg
Transmitter: 133 H, 426 W, 450 Dmm ≦ 13.5 kg</td></tr>
</table>

SPECIFICATIONS

RECEIVER

Frequency Marker	SLIDE	Variable Slide Markers: 70 ±25 MHz, 140 ±50 MHz
	2 MHz COMB + SLIDE	2 MHz Comb markers + Variable side markers.
	Accuracy	Counter display with resolution 10 kHz.
X-Y Recorder Output (Option)	Output	X: 0 to 4 V Y: 0 to 4 V Pen lift: open, Pen down: Ground
	Sweep Speed	20 sec, 40 sec
Phase Detector Capture Range		±5 Hz ≦ 555.556 kHz, 5×10^{-6} ≦ 12.39 MHz
EXT SWEEP Input (rear panel)		Frequency: 18 Hz to 100 Hz, Level: 0.5 Vp-p to 2 Vp-p
BB OUTPUT (rear panel)		−7 dBm/75 Ω

Inherent Noise (IF to IF)	Group Delay	Linearity	Differential Phase	Differential Gain	Detector Band: 3 kHz
	66 to 93 kHz: 0.3 ns rms 200 to 278 kHz: 0.1 ns rms 400 to 556 kHz: 0.05 ns rms	0.02 % rms	0.05° rms	0.1 %rms	
	Deviation: 200 kHz rms, f_M<1 MHz		Deviation: 500 kHz rms, f_M = 5.6 MHz		

TRANSMITTER

SWEEP OUTPUT Frequency	Line (50/60 Hz), 70 Hz, option (one frequency between 18 Hz and 100 Hz can be designated), EXT. (18 Hz to 100 Hz).
EXT SWEEP Input (rear panel)	Frequency: 18 Hz to 100 Hz, Level: 2 Vp-p, Impedance: 10 kΩ
EXT BB Input (rear panel)	Frequency: 80 kHz to 15 MHz, Level: −7 dBm, Impedance: 75 Ω
IF CENTER FREQUENCY' Accuracy	Frequency: 45 to 95 MHz, 90 to 190 MHz, 10 kHz resolution panel display.
SWEEP WIDTH	70 MHz band: 0 to ±25 MHz, 140 MHz band: 0 to ±50 MHz, 0.1 MHz resolution panel display. Auto Sweep Reduction: Modulation frequency >1 MHz.
FM Deviation	0.5 to 1000 kHz rms, 1 kHz resolution panel display.
BB FREQUENCY	Low freq.; A type – 66.666, 200 and 400 kHz, B type – 92.593, 277.778, 555.556 kHz, C type – 83.333, 250, 500 kHz, High freq.; 2 (type A), 2.4 (B, C type), 3.58, 4.43, 5.6, 8.2 MHz 12.39 MHz (ME538A/B/C), EXT: 66 kHz to 12.39 MHz. Accuracy: Low freq. – ±5 Hz, High freq. – $\pm 5 \times 10^{-6}$.

CHART OF GROUP-DELAY MEASURING ERROR DUE TO AM-PM CONVERSION

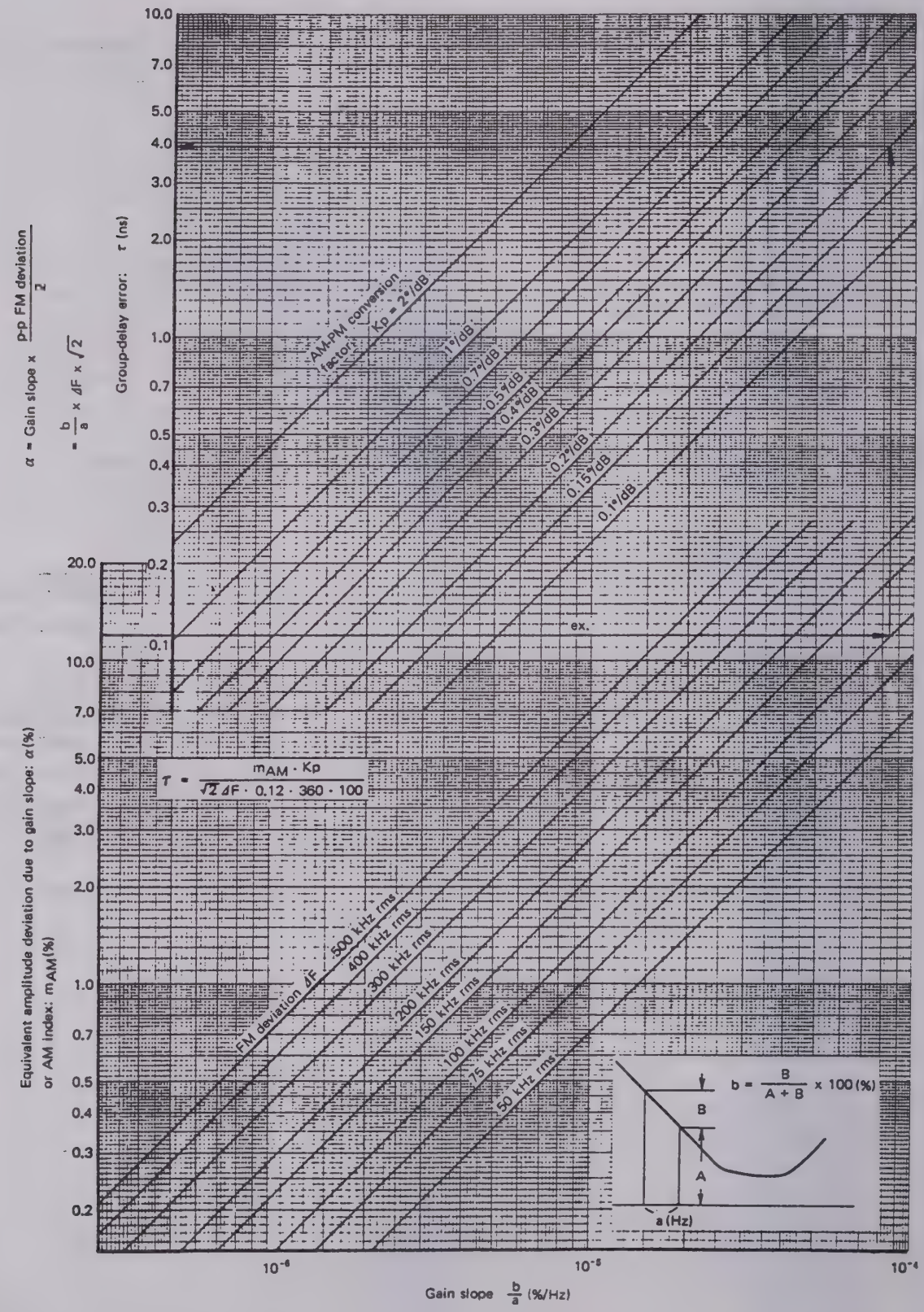
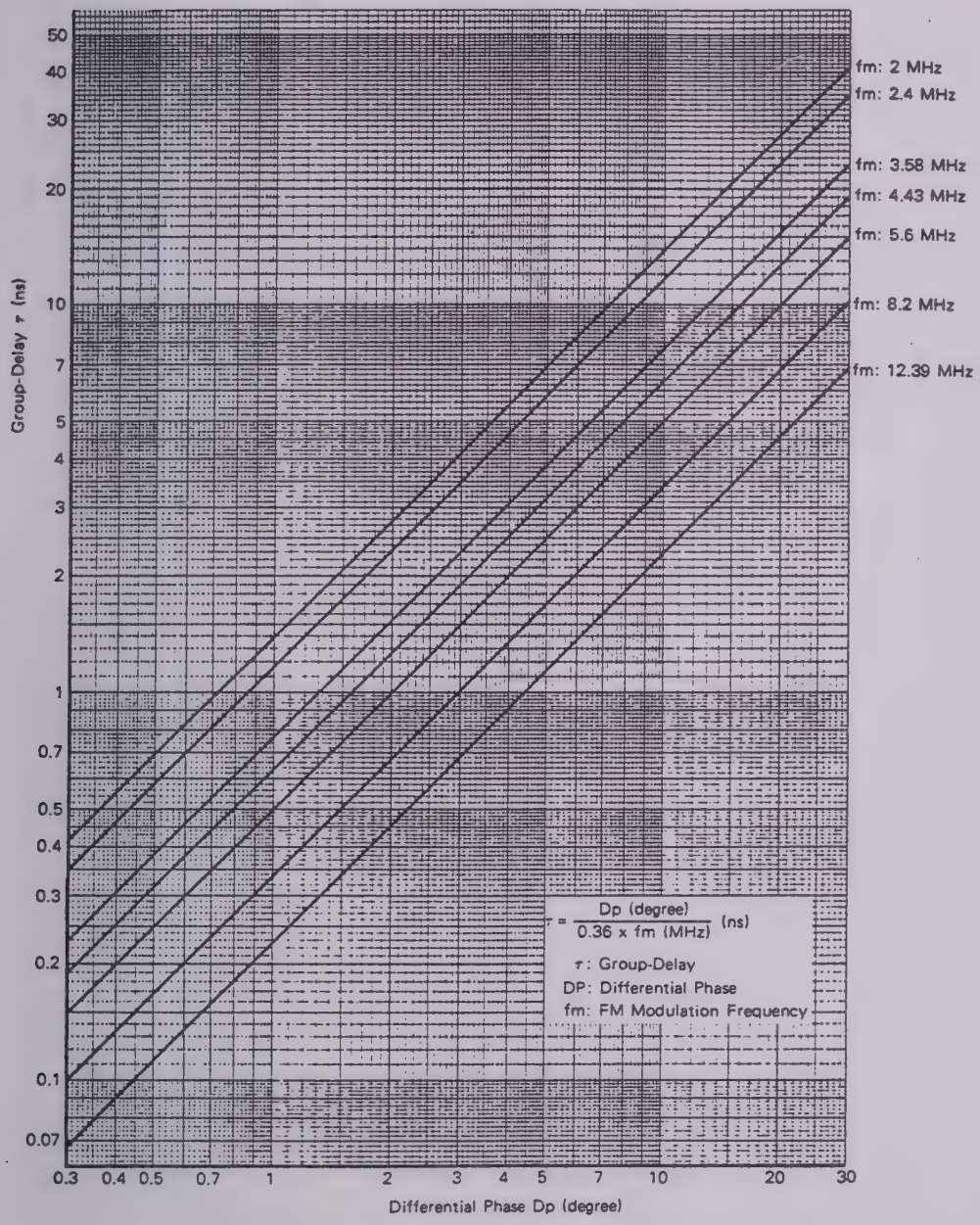


TABLE OF CONVERSION OF GROUP DELAY AND DIFFERENTIAL PHASE



ANRITSU ELECTRIC CO., LTD.

10-27, Minamiazabu 5 chome, Minato-ku, Tokyo 106 JAPAN
Phone: Tokyo (446) 1111 Cable: "ANRITDENKI TOKYO"
Telex: 0-242-2353 ANRITU J

www.manualsplus.com
1034418